CANADA

A STUDY OF COOL CONTINENTAL ENVIRONMENTS AND THEIR EFFECT ON BRITISH AND FRENCH SETTLEMENT

by

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PREFACE

FIVE years ago I published a volume in the same series which dealt with the continent of Australia. It was based on a quarter of a century of residence, travel and teaching in that continent; and it was by no means easy to be sure that no important matters were omitted in that volume, in spite of my long acquaintance with the region surveyed.

It has been my good fortune to travel extensively in the other six continents, as well as in Arctic lands. For seven years I resided in the United States, but it was not till 1935 I began an intensive study of the vast Dominion of Canada. It is nearly one and one-half times the size of Australia; and now, after ten years' residence at the University of Toronto, I still feel that there are countless geographical problems awaiting solution. However, every text-book is merely a stage towards something better, which will appear as more knowledge accumulates; and much should be forgiven the pioneer—who has little to build upon.

The book is based on extensive travels; including four traverses across the Dominion through the 'populous zone', as well as a survey of the North-West Territories (near the Mackenzie River) and of the Yukon and the new Alaska Highway. I spent some weeks north of the Arctic Circle in this corner of the Dominion; but unfortunately have no personal knowledge of the eastern Arctic lands. Though these are very interesting, they can hardly be called important, since today there are barely 100 white folk living therein. In 1945 I made a survey of Newfoundland settlements.

I have to thank various Canadian Government officials, to whom I have applied for information, for their uniform courtesy; especially Dr. Camsell and his staff at the Department of Mines and Resources at Ottawa. Dr.

Patterson and the staff at the head Meteorological Office have always been willing to furnish me with data which I have requested. Several of my colleagues at the University of Toronto have given me a good deal of help, and I must thank especially Professor H. A. Innis and my geographical colleague Professor D. F. Putnam.

The *Canadian Yearbook* is indispensable to geographers, and it will be found that I have borrowed a good deal—including a few charts—from its pages. All Canadian students of geography owe much to the fine memoir on Canadian forests by Mr. W. E. Halliday ; and the numerous official publications dealing with the North-West Territories have also been consulted extensively. I wish also to record my appreciation of the large amount of research, especially in economic geography, which is being published in the *Canadian Geographical Journal*, now in its fifteenth year. The Department of National Defence and the Bureau of Geology at Ottawa are responsible for several of the photographs.

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14 July, 1945

SECOND EDITION

Several maps have been added or redrawn. I have to thank a number of readers, especially Professors M. Y. Williams, R. Legget and J. L. Robinson, for helpful suggestions.

The rapid sale of the first edition has enabled me to make a number of emendations in the work and to enlarge the index.

THIRD EDITION

Statistics have been revised and a few maps added.

1957

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POSITION, DISCOVERY, AND GENERAL PHYSICAL FEATURES

CHAPTER I

INTRODUCTION

CANADA in the broadest sense includes nearly 4 million square miles of territory. It is therefore far larger than any other section of the British Empire; for Australia is less than 3 million, the Indian Empire about 2 million, and South Africa about 1 million square miles in area. Its vast extent is therefore the dominant feature of Canada. But much of this huge area is undeveloped, and indeed undevelopable; as may be gathered from the fact that the United States, with a much smaller area, has ten times the population.

We learn at the start of our study that *area*, in itself, is not a very valuable asset, if Nature has not endowed it with an environment suitable for man's occupation. It will be found very profitable in a later section to compare the environments of Canada and United States, partly to explain this discrepancy—but partly also to deduce what population Canada may be expected to support in the future.

A further problem of great interest to the geographer depends on the differences between Canada's environments and those of the home lands from which her settlers, whether British, French, Scandinavian, German, or Slav, were derived. There is little in common between the warm, wet lands of France and Britain and the cold continental expanse of Canada. In January only a small district near Vancouver has an average temperature above freezing-point. In France and Britain temperatures (except in the Highlands) are almost always above 32° F. Of course, it is the winter temperatures in the heart of Canada which differ most markedly from anything found in Europe. Near Hudson Bay the range of temperature (chiefly due to the low figure in winter) is about 80° F. In France and Britain the maximum range is near 30° F. Only in Siberia is there a region with a climate comparable with that of Keewatin (west of Hudson Bay). We shall therefore in our study try to answer the question, 'How have West European peoples fared when transferred to an environment which in some respects resembles Siberia rather than the mild lands of Britain and France?'

Let us now briefly consider the broader structural features of Canada. In general, they are simpler than those which have played so large a part in the cultural and economic development of Europe. In the latter continent we see five structural belts building up the various national environments. The Russian Shield determines the

extensive plains of the eastern and Baltic lands. The belt of ancient 'Caledonian Folds' greatly affects Britain and Scandinavia, and the later 'Armorican Folds' cross Europe from Cornwall to the Crimea. The much interrupted 'Carboniferous Syncline' (from Glasgow to the Donetz region) has given rise to the densely populated industrial belt of Europe. To the north of the Mediterranean Sea we find the barrier of the complex 'young mountains' of the 'Alpine Storm', which, relatively, was elevated 'only yesterday,' i.e. in middle and late Tertiary times.

Canada in general has a much less complex build. Much of it comprises the great Canadian Shield, which forms the actual surface in the east; and underlies level-bedded later sediments in the centre and north-west, thus resembling Finland and Russia. Only in the extreme south-east, i.e. the Maritimes, are there districts affected by the Paleozoic foldings similar to the Caledonian and Armorican 'Storms' of Europe. There are no 'young mountains' in Canada except in the far west in British Columbia, &c., where indeed the Rockies and the somewhat older Selkirks and Coast Ranges rival the elevations of the Alps. Thus Canada in the broadest sense is a vast shallow basin—whose centre is drowned by the sea, forming Hudson Bay. The rim of this basin is broad and high in the west, low and much broken in the Polar Archipelago on the north, moderately elevated on the east, and low on the south.

Into this basin there are four main corridors from the east and south-east—the natural direction of approach in the early days. Two of these are water-gates by way of Hudson Bay and the St. Lawrence; two are land-gates, i.e. by way of the Mohawk Valley and the Mississippi-Red River route. Of these the St. Lawrence has always been the chief, since it leads into a waterway of lakes so well linked as to be in some slight degree comparable to the Mediterranean corridor bordering southern Europe. Only in east central Africa is there a group of fresh-water lakes as striking as those linked to the St. Lawrence. In Africa, however, the lakes are completely separated from each other, and man has never made such a corridor of them as in the case of the Superior-Ontario group.

Today the population of Canada is clustered in four or five different environments; but all are strung along the southern border in response to the paramount importance of temperature control. We may usefully contrast this distribution with that obtaining in Australia. In the southern continent rainfall is a stronger factor than temperature as regards population. The regions with suitable rainfall are naturally near the sea, and are, in fact, confined to the south and east coasts. Hence marine transport has been a great factor in linking the scattered settlements in

the past. Only in later years did the railways become of great importance in this connexion. In Canada, however, coastal shipping has been of little or no value in uniting the various provinces (except in the extreme east); and the railways have been the great medium of transport, linking province to province, and pioneer areas to the older centres of industry (Fig. 158).

The chief distinction, however, between the two British Dominions, is based on the character of the settlers, and on their very different evolution. It is not much exaggeration to say that Australian history has been lacking in striking incidents. There has never been (until the recent war) a battle or even a skirmish of note; since the aborigines were relatively few, and quite unable to oppose the advance of the white pastoralists. Moreover Australia was so far from other lands that other powers left the British alone after the first settlement in 1788. In Canada, the strength of the united Iroquois Confederacy, which hindered early French settlement for over a century; the bitter enmity between French and English in Canada and elsewhere during much of the time from 1500 to 1765; the rivalry between the English (at home and in Canada), and the rapidly growing power of the United States in the south which burst into open war in 1776 and in 1812; the several armed rebellions of the half-breeds under Riel and others as late as 1885; the troubles with Spain, Russia, and U.S.A. on the Pacific coasts up to 1846; there is nothing comparable with these moving events in the annals of the sister dominion in the south.

Of greater sociological import is the parallel development of a French Canada and a British Canada. In later decades the vast influx of Germans, Slavs, and Scandinavians has also much complicated the pattern. In Quebec 80 per cent are French, and in New Brunswick 33 per cent. In the three prairie provinces about 40 per cent are of non-British origin. Only in the coastal provinces of huge British Columbia on the Pacific, and in tiny Prince Edward Island on the Atlantic side, are the Canadian settlers almost wholly of British ancestry. By contrast we may agree that much colour is lacking in the pattern of Australia's history, where 98 per cent of the whole population is of British stock.

If we consider Canada as a whole there are eight or nine major subdivisions of the Canadian environment. These are of course mainly due to differences of latitude and topography. It is enough at this stage to list these subdivisions as follows:

(1) The Maritime Provinces, with a marine climate and topography based on ancient folded mountains.

(2) The eastern Farming Areas, with a moderate continental climate.

(3) The Pre-Cambrian (or Canadian) Shield, mostly covered with coniferous forest (Taiga).

(3a) The Shield where modified by the silts of ancient glacial lakes.

(4) The Prairie Provinces, characterized by a very cold winter.

(4a) The north-western Taiga based on level-bedded sedimentary rocks.

(5) The Rocky Mountains and associated ranges of the far west.

(5a) The narrow Pacific coast, rugged and wet, but with mild climates.

(6) The Tundra (treeless plains) north of the Taiga.

Samples of all these major divisions (except the northern Tundra) are encountered on a journey across Canada through the southern

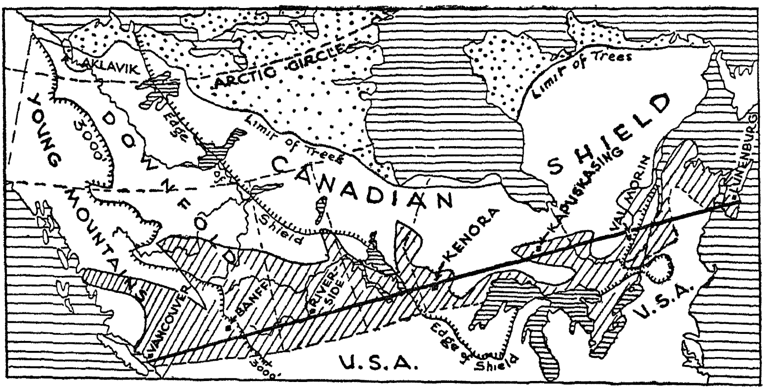


FIG. 1.—Some of the main physiographic divisions of Canada; showing the seven 'samples' along the traverse from Lunenburg to Vancouver. The three topographic divisions (Mountains, Downfold, and Shield) are indicated. They are crossed by two other isopleths, the 'Limit of Trees', and the northern edge of the 'Populous Zone'. Between these two lines occurs the main Taiga (Conifer forest). (See plates on pp. 10, 176, 192)

occupied portion of the vast Dominion. We cannot do better than to commence our study by making such a traverse of 2,700 miles, say from Halifax in Nova Scotia to Vancouver in British Columbia. Let us imitate the geologist who wishes to sample a very extensive area of low-grade mineral country. He marks a straight line across his region, and then takes grab-samples at equal distances along this line. Let us take our 'grab-samples' at intervals of about 450 miles; and photographs of these various type localities are reproduced (in Plates I to IV). They will give the reader a very fair idea of the varied topography and resources of occupied Canada. It must, of course, be realized that these samples do not represent the huge territory of some 3 million square miles which may be called 'Empty

PHOTO 1.—COAST SCENE NEAR LUNENBURG, NOVA SCOTIA

PHOTO 2.—VAL MORIN NEAR MONTREAL ON THE SHIELD

Canada'; but only the southern strip, which is about 300 miles wide. However, owing to the meridional arrangement of the chief Canadian environments, samples of almost all the types except the Tundra are crossed in our traverse.

It is clear from Fig. 41 that an environment marked by an almost universal cover of coniferous forest is the most widespread feature in Canada. This cool, temperate forest the geographer calls Taiga (*pron.* Tah-eè-ga). Large areas of this forest on the southern side consist of fine specimens of pine and spruce. But much of Canada exhibits a low undulating topography of 'granite shield' (in the east and centre) and of widespread Cretaceous plains in the west. This is covered with many lakes and marshes, occupying hollows in the veneer of relatively recent glacial debris. To this type of marshy country, partially covered with small pine, spruce, and tamarack, the name 'muskeg' is given locally. 'An undulating muskeg-covered plain' is the most characteristic motif in the landscape if we consider Canada as a whole.

A Sample Traverse across Canada

As stated, I have found it a very useful plan to introduce a new area to students by showing them 'sample photographs' along a definite traverse. To be of value these samples should be taken at regular intervals, with a view to showing *average* characteristics rather than especially picturesque or prosperous localities. I have therefore laid down a traverse between Halifax and Vancouver, and introduced seven views at intervals of about 450 miles. It must be understood clearly that this section is precisely along the middle of the 'settled fringe' of Canada; therefore it does not show the character of the Barren Grounds (or *Tundra*) which occupy much of the north. But all the other main environments of the huge Dominion are illustrated.

The first photograph is a view of the Atlantic coast in Nova Scotia, about 35 miles west of Halifax. Here the ancient rocks of the province are covered with debris of the Ice Ages. This is often piled into oval mounds about half a mile long called 'drumlins'. The pretty island in the centre of the view is such a drumlin, and three more can be seen in the distance. A typical pine tree appears on the right; and the rather stony character of the soil, which is not of much use for agriculture, is apparent in the foreground. The harbour is a part of Mahone Bay; to the west of which is Lunenburg, the great fishing centre of Nova Scotia. Some of the small fishing boats appear in the photograph. Many folk of German and Dutch descent are found in the Lunenburg area. Several neat summer residences, probably owned by Americans, appear on the little island.

In the first stage of our journey we cross the plain of New Brunswick, and the flat summits of Notre Dame Mountains, which rise to 2,000 feet. They are part of the elevated ancient Appalachian folds. After crossing the depression of the St. Lawrence valley, which seems to have been a *graben* (depression) through long geological ages, the great Canadian Shield is reached near Montreal. Some 50 miles to the north-west of this city we reach the middle of 'Ski-land'. Here the extremely ancient granites of the Shield reach an elevation of about 1,700 feet. The rounded character of the hills, the mature valleys and the scattered forest are well shown in the second photograph. It depicts Sun Valley near Valmorin, which is a popular centre for riding and hiking in summer, and for ski-ing in the winter. There is a little farming in the sheltered valleys and some lumbering; but in general the climate and soils are not suited for agriculture in this part of the Shield. Country like that shown in photograph 2 extends for several hundred miles to the north of Valmorin; and it is without settlement, except where the Canadian National Railway crosses it. A few miners, trappers, and Indians constitute the population in the northern parts of the vast province of Quebec.

As we continue our traverse to the west the same sort of country is encountered for a hundred miles or so. Now, however, the Shield appears somewhat flatter, and the hollows are filled with white clay, which may be many feet deep. We have reached the great Clay Belt, and our next photograph (3) shows us an extensive area of this type of landscape around Kapuskasing (*pron.* Kàppus-kày-sing). The view is taken from an aeroplane looking to the east along the Canadian National Railway. Kapuskasing River cuts across the picture, flowing to the north, i.e. to the left (p. 26).

In the distance, at the left in photo 3, we see some of the numerous shallow lakes (L) scattered over the Shield. Where the land has been cleared by farmers the surface appears grey, owing to the light colour of the clay. The darkest patches are 'muskeg', i.e. swamp areas filled with mossy sphagnum, but carrying some spruce and tamarack (larch). A close look at the photo will show the curvilinear plan of the little 'Company Town' of Kapuskasing (A), just to the north of the railway bridge over the river, which is marked by a cross. The big paper mill (B) is just across the railway to the south-east. A small village (C), of ordinary *private* development, is to be seen just to the north-east of the 'company town' on the road to the east. Rafts of logs brought down the river to the mill appear as white patches (D) on the right.

The next stage of our traverse takes us right across the Shield north of Lake Superior over country much like that at Kapuskasing, but with poor soils in general, which have not been benefited by the

clays of the former giant ' glacial lakes '. After about 500 miles we reach Kenora on the Lake of the Woods, where the fourth photo was taken. The town is close to the famous Rat Portage of the early days, which was used by the voyageurs on the canoe route from Lake Superior to Lake Winnipeg. Indeed, ' Kenora ' is a compound name, in which the last two letters refer to Rat Portage. The region is undulating with many pockets of silt, some of which are utilized for farms. Kenora has flour mills, based on the wheat of the prairie, whose eastern edge is nearby. The large lake is frequented by tourists and by visitors from Winnipeg; and a considerable air transport has developed to the numerous valuable mines, such as Red Lake, in the Shield to the north and east.

We now cross the rich silts which mark the floor of former glacial ' Lake Agassiz ', and reach the Cretaceous deposits which build up much of the Canadian prairies. These are relatively free from trees, and are becoming closely settled by farmers, growing wheat for the most part. The view in photo 5 shows us the South Saskatchewan River, about 100 miles above (i.e. to the south of) Saskatoon (p. 160). The rainfall hereabouts is 14 inches, and the farms shown on the right and in the background are almost wholly devoted to wheat. They have an average size of about 400 acres. The river is of a ' braided ' character, winding from side to side of its flood plain. It has cut down about 100 feet below the general level, producing bluffs which have somewhat the form of ' badlands '. The river has, in fact, just left the higher levels of the ' Coteau ' (or cuesta), which crosses the prairie to the north-west (from Moose Jaw to Biggar). In this Riverhurst district, but not shown in the picture, is the ' Elbow ' of the river, where a former channel led to the Qu'Appelle River, and so eastward to the Red River at Winnipeg (Fig. 60).

Continuing our traverse to the west for about 400 miles we reach the sharp margin of the Rockies; where the crustal overthrust from the west has moved older rocks over the younger Cretaceous rocks in places. The Rockies near Banff rise to 11,600 feet at Mt. Temple, and many of the peaks on the Continental Divide are over 10,000 feet. Our photo (6) is an aerial one taken from the Windermere road about 25 miles west of Banff. It shows a typical glacier-cut valley with its rounded cross-section. Boom Lake is in Alberta and occupies the head of the valley, which is definitely a cirque, with a considerable snowfield hanging on the east wall of the Divide. The high flat mountain on the right is Mt. Quadra (10,420 feet), which forms part of the continental divide separating Alberta from British Columbia. The little lake extends back to the white line, and contains a reflection of the snowfield above. The pyramid shape of the level-bedded Cambrian rocks is marked in the photo-

graph. The talus slopes and the flattish floor of the valley are covered with forest, consisting mainly of Engelmann Spruce.

Between the Rockies and the coast extend half a dozen north-south valleys due to the complicated folds in the crust of British Columbia. The valleys invariably contain large rivers or elongated lakes, while the ridges are capped with glaciers in the Selkirks and Rockies. At the end of our last section we reach the coast at Vancouver. This fine young city of 250,000 people is shown in the last photograph. Here we are looking north to the 4,000 feet mountains across Burrard Inlet. The Lion Mountains are capped with snow, and tower above the Capilano Canyon. North Vancouver is a suburb at the mouth of the latter valley. The half a dozen skyscrapers of Vancouver in the vicinity of Granville Street crown the summit of the older part of the city. The low wooded promontory just to the left of the high buildings is Stanley Park; which is linked by a high bridge (over the First Narrows) with North Vancouver (see Photo 7, p. 192).

The last photograph in this series of eight does not belong to the traverse across Canada, but is one of the most interesting taken by the author. It shows the barn and some of the dairy herd at Aklavik (p. 192). This experiment in Canadian settlement has been going on for a number of years, in lands cleared from the coniferous forest 125 miles north of the Arctic Circle. Some of the spruce trees in the background are 18 inches in diameter. The cows graze on the rough grass, but much green feed in the form of oats is grown in Aklavik itself (see p. 271). (The farm was closed in 1945.)

On our traverse of 2,700 miles we have seen samples of almost all the Canadian environments. We have learnt something of the vast extent of the Shield and the Prairies. The reader will have gathered that the vast plains in the interior are the most attractive of the relatively empty areas in the Dominion. Of course, much of the east is fast becoming industrialized. The far west is famous for its grand scenery, but this rarely indicates lands suitable for close settlement. It is the purpose of this book to analyse the various environments, and to suggest where the future millions of the Canadian nation will do well to look for their homes and their employment.

Method of Investigation

Following the Introduction the next chapter deals with the structure or build of the Dominion in the broadest sense. First we study its geological history, which is essentially the folding of the weaker strata against the margins of the Great Shield. In this fashion have been produced the Appalachians, and the later Rocky Mountains and associated ranges. The emergence of the western

Prairies, which were formerly the silts and muds of a Cretaceous Sea, have given us our most fertile farmlands. The waxing and waning of the Ice Ages, during the last million years, have entirely altered the topmost strata which determine the landscape; so that a 'juvenile complexion' has been given to the senile face of the Canadian Shield. The slow reaction of the crust to the removal of the gigantic load of ice has led to marine invasions in the east, which in turn have retreated and left fertile soils behind. These have covered the glacial 'till' due to the Ice Ages.

A study of the more striking topographic features follows. The distribution of rivers and lakes is naturally of great importance, and Canada is well endowed with both. The waterways were of special significance in the early days of settlement, when passengers and goods were carried by canoe from Quebec in the east to the Peace River, and thus into British Columbia in the west. No other part of the world has seen such a widespread use of small boats over such huge distances.

The other element of note in the environment besides the topography is the climate. A number of official and private studies make it relatively easy to discuss the various types of Canadian climate with some accuracy. Every variety of temperate and polar climates is present, from the wet marine climate of western Vancouver Island (with 200 inches of rain) to the dry tundras of the Barren Grounds or the ice-caps of Ellesmere Island. We range from the warm regions near Lake Erie, where vines and tobacco flourish, to the arid intermont valleys of British Columbia, where the sage-brush and cactus are almost universal.

The first five chapters so far summarized constitute Part I of the book. The second part describes the score of Natural Regions into which the Dominion can be divided. Here the interaction of environment with human interests is discussed, with the main emphasis laid on the regional interplay. There are various ways of deciding upon the Natural Regions in a territory as vast as the Dominion, and these are compared. I use 20 of these regions, each more or less homogeneous, but differing greatly in size.

It has seemed logical to use the progress of settlement in deciding the order of presentation. I have therefore first of all discussed the regions which are rather *closely settled.* Of these there are four in the east, two more constitute the Prairie Regions; while British Columbia is so diverse in its topographic setting that five regions must be considered. The second major group of Natural Regions includes three *Transition* areas, sometimes called the Pioneer Fringe. They consist of Newfoundland, the Clay Belts of the Shield, and the Peace River Block. Then in the third group are the vast *Empty* areas. Of these there are half a dozen regions on

the Mainland, and finally the huge area known as the Canadian Polar Archipelago.

In the third part of the book the various geographical problems are tackled in a more general fashion. The great industries, such as those dealing with Fur, Fish, Forests, Farms, and Factories, are charted, and the major physical controls are pointed out. This section offers a good illustration of the conflict between the views of the Possibilist and of the Determinist in their outlook upon geography; and some little attention is given to this matter. The book closes with chapters on Mining, Communications, Population Trends, and Imperial relationships.

Population of Canada in 1958 (in thousands)

Ontario	5,803	Nova Scotia	710
Quebec	4,884	New Brunswick	571
B. Columbia	1,544	Newfoundland	438
Alberta	1,201	Prince Edward Is.	100
Saskatchewan	888	N.W. Territories	20
Manitoba	870	Yukon	18
		Total	17,048

Origins of Canadians in 1951 (thousands)

British	6,709	Scandinavian	283
French	4,319	Netherland	264
German	620	Polish	220
Ukrainian	395	Others	1,198

For Areas of Provinces and earlier population data, see p. 495. A new book *Canadian Regions* (Putnam and others, Toronto, 1952) is very useful, especially regarding economics, maps and photographs.

CHAPTER II

EXPLORATION OF CANADA

The Discovery of Canada's Coastlands

CANADA has been ' discovered ' many times in man's history. Despite the views of certain anthropologists, the writer believes that man reached Alaska and Canada by way of the Bering Corridor *before* the last Ice Age. These explorers were probably heavy-browed dokeph (narrow-head) aborigines, not unlike the primitive folk of Australia. People of this Qurungua type still exist in the wilder parts of Bolivia.[1]

The main tribes of Amerinds no doubt arrived much later, probably within the last 20,000 years. The writer thinks it likely that the Eskimos were early migrants into Canada ; but we have no real evidence as to the date ; and many authorities place their arrival later than that of the dokeph Amerinds. The latter were followed by the brakeph (broad-head) Amerinds of the west of Canada and the United States. As usual, the later migrants are found nearer the general corridor of migration, which in America was probably along the Mackenzie Valley and then just to the east of the Rockies. The earlier Amerinds were pushed away from the corridor ; in the case of America into the eastern forests of Canada and the States. Dixon has pointed out that the tribes between Long Island and Lake Erie have a number of skeletal characters which suggest that they have some affinity with primitive negroid peoples. In accord with the principles of migration which I have elaborated in *Environment, Race and Migration*, we must look to *South* America for the most complete evidence of the early comers into the New World.

The first Europeans in Canada were undoubtedly the Vikings from Greenland. Eric the Red made an important settlement in 982 in south Greenland, which survived until early in the fifteenth century. A Runic stone found near Upernivik shows they reached north to 72° 55′. About the year 1000, Leif, son of Eric, sailed to the west. Turning to the south Leif reached ' wooded shores on a level land ', which they called Markland. This would seem to suggest Cape Breton Island rather than Newfoundland. Two days later they reached the famous Vinland. However, since authorities

[1] These aborigines are discussed and illustrated in my *Environment, Race and Migration*, Toronto, 1937 (Third edition, 1946). Note *Amerind* means American Indian. (The Chinese may have landed in A.D. 500.)

are entirely disagreed as to the real character of the fruit found here, whether grapes or cranberries, not much can be based on this name. It may well have been Nova Scotia. They made other voyages to this region in later years; but seem to have preferred their Greenland homes, owing to the hostility of the Eskimos and Amerinds.

As I have written elsewhere, it is not improbable that the Norsemen of Pre-Columbian days penetrated somewhat farther into North America than is currently supposed; for signs of their journeys in the form of inscribed stones and Viking weapons are reported almost from the heart of the continent. The 'Kensington Stone', from western Minnesota, has an inscription in Gothic runes to the effect that 'in 1362 eight Swedes and twenty-two Norwegians made an

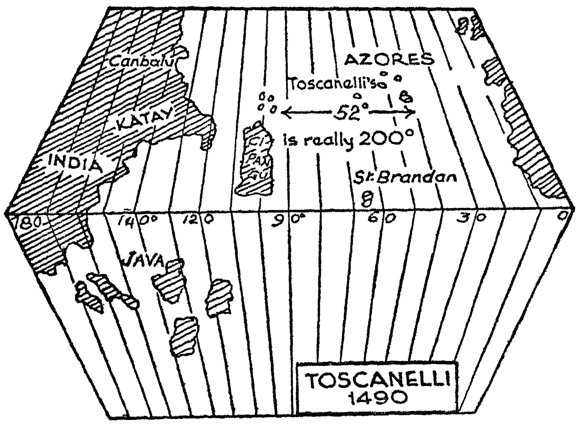


FIG. 2.—A hypothetical chart illustrating Toscanelli's views of the region between Azores and Cipangu (Japan). (Based on J. Jacobs)

exploration from Wineland to the west'. The recent discovery of Viking sword, axe, and shield buried under a crag to the north of Lake Superior seems to suggest an expedition along the St. Lawrence long before the journeys of the early French explorers in this region. These interesting objects are now on exhibit in the Royal Ontario Museum (Toronto). The blond Eskimos of the Coppermine River, and the blue-eyed Mandan Amerinds of North Dakota, may preserve traces of Viking ancestors.[1]

The Genoese Columbus discovered the West Indies for the Spanish King in 1492. It is worth while to digress for a few minutes to consider what his contemporaries thought of the globe to the west of the Old World. Toscanelli about this time produced a chart

[1] R. Hennig in *Zeitschrift für Rassenkunde,* 1937, pp. 20–8.

which suggested that Japan lay only 52 degrees to the west of the Azores. (Actually it is about 200 degrees away.) This chart disappeared, but a hypothetical reconstruction (after Jacobs) appears as Fig. 2. Columbus was influenced by Toscanelli's calculations; and when he reached the West Indies, after sailing about 45 degrees, he naturally assumed he had reached eastern Asia.

Other sailors and nations were moved to emulate his discovery; and John Cabot, a seaman from the rival city of Venice, in the service of the English King Henry VII, sailed from Bristol to the west in 1497. His voyage resulted in the discovery of Newfoundland. We owe most of what we know of Cabot's voyage to letters written by Italians in England after his return. Soncino writes: [1]

> He expects to go from that place already occupied, constantly hugging the shore, farther towards the east until he is opposite an island called by him Cipango (Japan) situated in the equinoctial region, where he thinks grow all the spices in the world. . . . The sea near the New found land is covered with fish, which are caught not merely with nets but with baskets . . . and this I have heard the said Zoanne (John) relate.

The above quotations illustrate that urge towards the trade of Asia which dominated North American exploration for centuries, i.e. the search for the North-West Passage. They also draw our attention to the vast supplies of fish on the Newfoundland Banks, which were the chief factor in the local trade for many decades. In 1498 John Cabot made another voyage in which it is possible that he discovered much of the coast from Hudson Bay to the Chesapeake in Virginia.

The greatest name in early Canadian history is that of Jacques Cartier, a sailor from St. Malo in France. In 1534 he entered the Gulf of St. Lawrence by way of the Straits of Belle Isle. Then he turned south along the west shore of Newfoundland, and reached Prince Edward Island and the Bay of Chaleur. Here he found to his disappointment that there was no route to the west. From Gaspé he coasted the isle of Anticosti, and then returned to the open Atlantic by Belle Isle. On his next voyage in 1535 his ships reached the site of Quebec, near a village called Kannata (i.e. Canada) by the natives; and in boats he proceeded further to Hochelaga (Montreal). He wintered at Stadacona near Quebec, and in 1541 spent another winter at Cape Rouge at the west end of the Quebec Horst (Fig. 51).

In 1542 Roberval went some way up the Saguenay, but failed to establish a colony in that region. Tadoussac at the mouth of the

[1] See the useful and concise account of Canadian Discovery by L. Burpee, *Roy. Soc. Can.*, 1937.

Saguenay was for many decades before Champlain's time a well-known centre, where French fishermen to the Banks obtained furs from the Indians in exchange for European goods. On Sable Island, a sandbank 100 miles east of Nova Scotia, De la Roche landed a number of settlers in 1598; but they were of very poor quality; and the few who survived the harsh environment returned.

Verrazano explored the coasts from New York to Greenland in 1524 as shown in Fig. 3. Fifty years later the map of America appeared as in Fig. 4. After this, in a sense, there were two major fields of exploration in the sixteenth, seventeenth, and eighteenth centuries, and these branched out from two different 'gateways'. We have seen how the early explorers fared in opening up the interior from the St. Lawrence 'Gate'. Cortereal in 1574, and

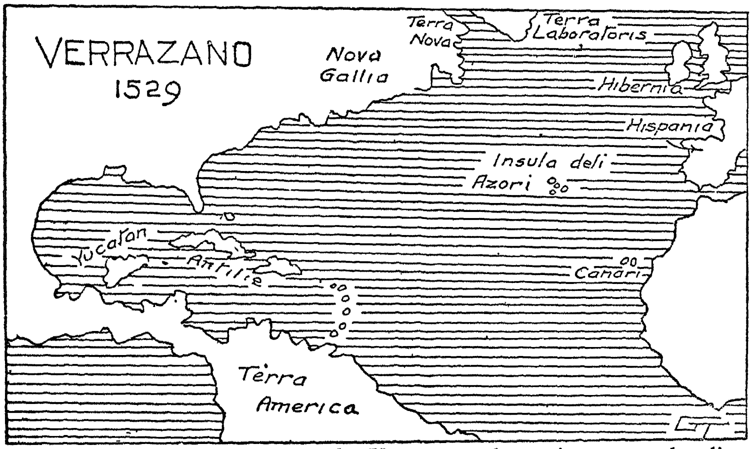


FIG. 3.—A contemporary map by Verrazano, drawn in 1529 and indicating Labrador and Newfoundland

Frobisher in 1576, started the search for the North-West Passage to China *via* Polar seas; and this quest was followed up until Amundsen in the *Gjoa* succeeded in getting his tiny vessel through in 1903–6. In August of 1576 Frobisher landed in Baffin Land, in one of the long gulfs which mark the south-east portion of that huge island. He brought back a load of 'fool's gold' (i.e. pyrites), but a later expedition to this area added little to our knowledge of this area. In 1587 Davis reached the Greenland coast near Upernivik, and he also explored much of the Baffin Land coasts.

Hudson first spent several years attempting the North-East Passage; and has been described as the father of whaling in the Spitsbergen Seas. He reached 81° N.—a latitude which was not excelled hereabouts until 1925. In 1609 he explored the Hudson

River near New York, being in the Albany region at the same time as Champlain the great French explorer. Then Hudson turned to the polar seas, and discovered Hudson Strait, and the great bay which bears his name. He was abandoned by his crew at the south end of James Bay; and later the mutineers managed to reach England safely.

Within a few years occurred another epoch-making voyage, that of Baffin, who followed up the discoveries of Davis. Baffin explored much of the great enclosed sea called 'Baffin Bay'. In 1616 he reached latitude 78° N. and discovered Smith Sound, that entrance to the Arctic sea which was not however traversed till 1852. He

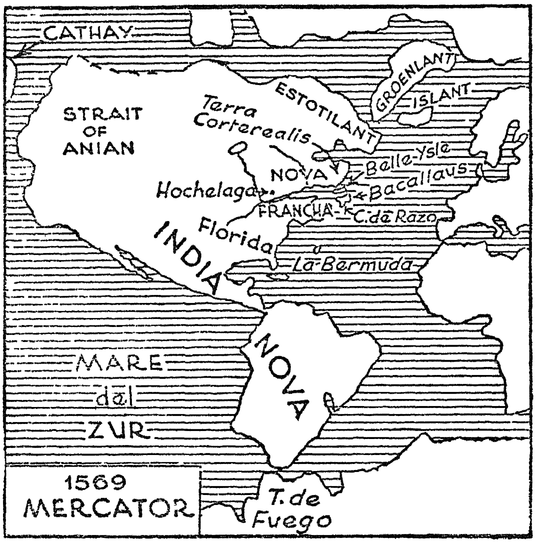


FIG. 4.—A contemporary map by Mercator (1569) showing a fair knowledge of north-east Canada

also found the most used entrance to the Canadian Polar regions—Lancaster Sound—though he placed it a little too far to the west (Fig. 5).

Various voyages about this time mapped the coasts of Hudson Bay. Foxe and James led rival expeditions about the year 1631. The former ventured into Foxe Channel to the north-west of Hudson Strait; while James surveyed much of the bay which received his name, as well as the south-west coast of Hudson Bay (Fig. 5). It is rather remarkable that there was no important exploration after 1632 in the Polar seas near Canada until early in the nineteenth century. A period of great wars occupied the

attention of the British and French, while Spain lost much of her initiative after the defeat of the Armada in 1588.

However, the Russians made some important discoveries in the far north-west of the continent. Dehzneff is said to have made a journey through the Bering Straits from the north as early as 1648. In 1728 Bering took a vessel (built in Siberia) through the straits which bear his name. A few years later, in 1741, he led a larger expedition to the east, and mapped much of the Alaskan coast

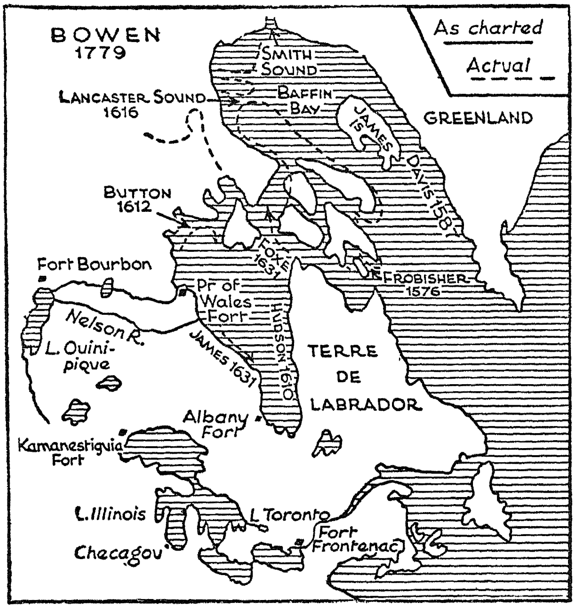


FIG. 5.—A chart by T. Bowen, published in Middleton's *Geography* in 1779. (No Arctic exploration occurred here from 1632 to 1818.) Eastern Baffin Land is charted as *five* islands. 'James Island' is non-existent. (Dates of some early explorers are added to the chart)

(Fig. 6). He wintered on a small island off Alaska, and died here of scurvy at the end of 1741. The English sailors, Cook and Vancouver, filled in many of the details of the coast of western Canada towards the end of the eighteenth century. On Cook's last voyage he explored the north Pacific coasts from Oregon northwards; and made the attempt to enter the Polar Sea by way of Bering Straits. On 18th August 1778 he reached dense pack ice in latitude 69° N.; but here he had to return. He was killed in a skirmish in the Hawaiian Islands in February 1779.

In 1791 the Spaniards sent out a scientific expedition—perhaps their most important—under Malaspina, to explore the coasts of the Pacific. Much geographical material was gathered in the vicinity of the great glacier in Alaska which bears the leader's name. As late as 1789 a prolific English writer named Dalrymple was convinced that a vast archipelago of islands extended between Hudson Bay and the Pacific south of Alaska.

Vancouver, who had sailed with Cook, is renowned for his careful survey of the intricate fiords and channels of British Columbia. This occupied him during much of 1792–4; during which period he circumnavigated Vancouver Island. Vancouver was specially ordered to investigate any openings which might lead across the

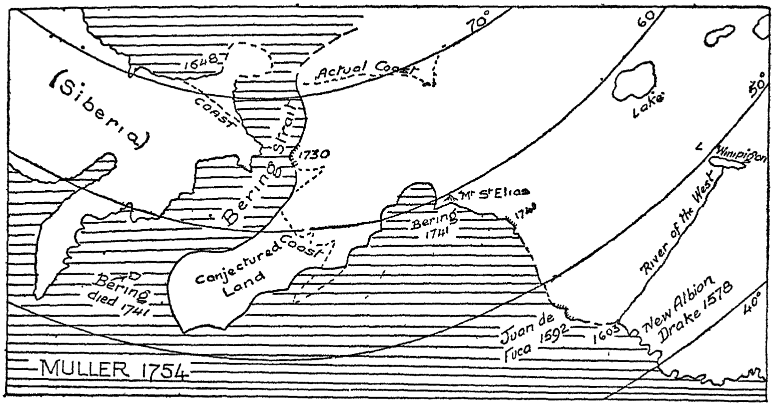


FIG. 6.—A chart published in St. Petersburg, and based on the voyages of Bering and Tchirikow. It illustrates the absence of knowledge of western Canadian coasts until the voyages of Cook and Vancouver

continent in these latitudes. It is of interest that he saw the breakers at the mouth of the Columbia River, but did not realize that they marked the outlet of the chief western river. Shortly after he met the American ship *Columbia*, which was the first to enter that important waterway. It is curious that he also missed the outlet of the Fraser River, though he named Point Grey just to the north. On the 20th July 1793 Vancouver was actually sailing along the coast (in Hecate Sound), when Mackenzie reached the adjacent coast after accomplishing the first crossing of the continent in these latitudes.

Exploring the Canadian Archipelago

After the Napoleonic wars Britain again turned her attention to

the exploration of the North-West Passage. Baffin's discoveries had been in some degree discredited, but in 1818 John Ross was sent to try to proceed by way of Smith Sound or Lancaster Sound, which had been discovered as long ago as 1616 (Fig. 7). Ross found that Baffin's charts were reliable, but did not add much to the map himself on this first expedition. One of his officers was Edward Parry, who is one of the most notable of Polar explorers. In 1819 he found that remarkable channel which leads directly west through the Canadian Archipelago. It bears various names; the east end being Lancaster Sound, the next portion Barrow Strait, then it opens into the central expansion of Melville Sound, and finally becomes McClure Strait at its western end (Fig. 7). Parry explored most of this natural 'corridor', but was unable to pass west of Melville Sound owing to the heavy pack ice in the channel beyond. Large islands fringe each side of the corridor, and we shall do well to note their names. Along the northern side as we proceed west are Devon, Bathurst, Melville, and Prince Patrick Islands; while along the southern side are Bylot, Baffin, Somerset, Prince of Wales, Victoria, and Banks Islands. To complete our picture of the Canadian Polar Archipelago, we should remember that only two important islands do not border this great 'corridor' of travel. They are Ellesmere Land in the far north, and King William Land in the far south.

Parry made a second expedition in 1821, proceeding along Hudson Straits and into Foxe Channel. Here he mapped Melville Peninsula, but could not penetrate the heavy ice at its northern end. It is of interest that the east shore of Foxe Channel was not properly mapped till 1927. In 1829 Ross made a second voyage and sailed down the north-west coast of Baffin Land. He explored Boothia Peninsula and fixed the position of the Magnetic Pole in this district. The expedition spent four winters in this area, and then was rescued by a whaler and reached England safely. (See note on p. 303.)

While Parry was exploring the Canadian Archipelago, the government despatched Franklin, an experienced explorer, to survey the north coast of Canada. Only a few points determined by Hearne and Mackenzie, &c., were so far fixed. Franklin made his base at Fort Enterprise, north of Great Slave Lake. In July 1819 he proceeded along the Coppermine River, launched his canoes on the Arctic Ocean, and surveyed the coast to the east as far as Cape Turnagain (Fig. 7). After a terrible return journey to Fort Enterprise, which he found to be abandoned, he ultimately reached civilization.

In 1825 Franklin again led a party down the Mackenzie, and then westward along the coast to the present boundary of Alaska. His associate Richardson surveyed much of the coast to the east of the mouth of the Mackenzie during the same period. During 1838

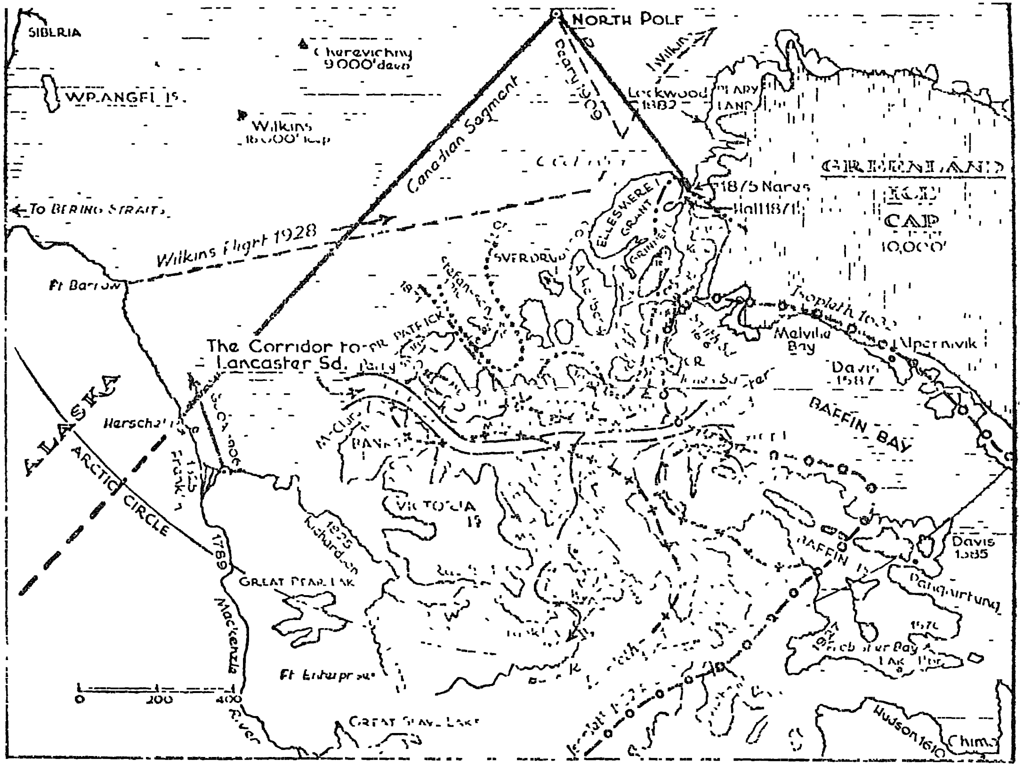


FIG. 7.—The Canadian Archipelago, showing the progress of exploration from 1600 to the present. Four isopleths of exploration, as at 1632, 1827, 1871, and 1910, are charted. The corridor along Lancaster Sound is emphasized. A is Amundsen in 1904; C is Cornwallis Isle; F is Franklin's Grave; W, Franklin in 1845. The Magnetic Pole has shifted 200 miles to NW. (See Fig. 98)

and 1839 Dease and Simpson, two officers of the Hudson's Bay Company, carried out their instructions to fill in the gap in the coastline between Cape Turnagain and the mouth of the Back River (Fig. 7.) They managed to reach as far to the east as Rae Strait, between King William Island and Boothia Peninsula. Hence by 1839 the whole coast of the Dominion was fairly accurately charted for the first time.

The most dramatic of all North Polar expeditions was that of the veteran explorer Franklin, which set out in 1845 to make a new effort to conquer the North-West Passage. His two ships contained 129 officers and men; and, sad to relate, every man died in the next few years in the vicinity of King William Island. Although Franklin was an experienced explorer, he and his officers left very meagre records of their journeys, and no complete account of the expedition was ever obtained. He wintered at the south end of Devon Island (w in Fig. 7). From here he turned south to reach the coast near Back's Fish River, whence he knew he could proceed along the mainland coast. His ships were beset off King William Island; and here Franklin died in June 1847. He was probably buried near Victory Pt. (King William Island). The unfortunate crew tried to sledge south to the mainland, and the coasts along this route were strewn with relics of their journey, including a number of graves. No less than forty bodies were found on Adelaide Peninsula at the end of their fatal journey.

When no news of Franklin arrived in England, relief expeditions were sent out, not only from England but from America, while the Canadians searched the northern coasts of the mainland. Most of the attention of the forty expeditions was given to the region along the main corridor, i.e. near Melville and Victoria Islands. Only a few of these journeys can be mentioned. That of McClure was the most spectacular. He reached Banks Island by way of the Bering Straits in 1853; and, after abandoning his ship in the heavy ice, was met by a party from Lancaster Sound with whom he returned to Baffin Bay. McClure therefore received the reward offered by the British Government for the first explorer to traverse the North-West Passage. It is of interest that the first vessel to reach the Atlantic Ocean from the west was a Canadian Police Patrol boat in 1942 (p. 303).

An American expedition under De Haven explored the shores of Devon Island. Rae and others charted the coasts of Victoria Island in 1851. Bellot in 1850 found the strait at the north of Boothia, while McLintock surveyed Prince Patrick Isle in the same year. The main details of the disaster were gleaned by Rae in 1854 from the Eskimos in the vicinity of Fish River (Fig. 7); and by McLintock in his journey around King William Island in 1857–8.

Although Franklin's records were never found, the various relief expeditions added 7,000 miles of new coastline (mostly in the Canadian Archipelago or the vicinity) to the charts of the middle of the nineteenth century.

The experiences of the Franklin Relief Expeditions seemed to show that the North-West Passage was not practicable from a commercial point of view. For this reason the attention of explorers in the north turned to an attack on the North Pole. We need not dwell on this endeavour in detail, except that the corridor via Smith Sound turned out to be one of the best approaches to the Pole. American Expeditions played a notable part in these discoveries, but a Britisher, Inglefield, was the first to traverse Smith Sound, and in 1852 he gave the name Ellesmere Land to one of the largest of the islands in the Canadian Polar Archipelago. The American Kane explored the large Kane Basin (Fig. 7) in 1854, while the British were fully engaged with the Crimean War. Hall in 1871 reached 82° 47′ along the coast which he named after Grant, and he died in this far northern region. The British expedition under Nares found unusually favourable weather conditions, so that his ship was able to reach the open water in the Arctic Ocean. Markham reached 83° 20′ on this expedition.

The American station of the First International Polar Year (1882) was placed in Ellesmere Land at Fort Conger, and considerable exploration in the interior of Ellesmere Land was carried on from this centre. The party was not relieved as arranged, and only six of the twenty-four members of the expedition were alive when the rescue party arrived. We may omit any discussion of the eleven expeditions of Peary, which were primarily concerned with the exploration of Greenland between 1898 and 1909. He reached the North Pole from Cape Columbia (in Canadian Territory) on the 6th of April 1909.

After 1850 only the north-west portion of the Canadian Archipelago remained uncharted. The isopleth for 1871 is shown on Fig. 7, and not much was done until 1899. In this year Sverdrup tried to reach the North Pole by the Smith Sound route, but was blocked by ice. Indeed, all *ship* exploration is very much at the mercy of the vagaries of the seasons. He sailed west along Jones Sound to the north of the main corridor and mapped all the northern portion of the unknown areas. He discovered Axel Heiberg Island and those adjacent to it, and also charted the west coasts of Ellesmere Island. Another Norwegian, Amundsen, chartered the little sloop the *Gjoa* (*pron.* Yer); and made what was the first successful attempt to traverse the North-West Passage in one ship throughout. He sailed along Lancaster Sound and the west side of Boothia Peninsula, and then decided to winter at Gjoa Harbour

(A in Fig. 7). Here he stayed two years, and then proceeded along the mainland coast to the mouth of the Mackenzie, where he wintered in 1905–6. On the 30th of August 1906 the *Gjoa* entered the Pacific, and so conquered the North-West Passage (Fig. 98).

Stefansson, a Canadian by birth, completed the survey of the other islands which lie to the west of Sverdrup's explorations. He spent most of the period from 1906 to 1918 in this part of the Arctic, and in 1916 he charted Borden, Brock, and Meighen Islands.[1] Various flights across the Arctic Ocean to the west of the Archipelago show that there is here a deep oceanic basin bordered by a wide continental shelf (especially on the Siberian side). There seems no likelihood of any lands being discovered in this ocean. Wilkins found a sounding of 5,417 metres to the north of Alaska in 1927. The Russian Cherevichny in 1941 obtained soundings of 1,856, 2,647, and 3,430 metres in the area about half-way between Wrangel Island and the North Pole (Fig. 7).

The Exploration of the Canadian Mainland

In an earlier section the discovery of the coasts of the Dominion has been described. Before considering the way in which the interior of Canada has been opened up, it is worth while discussing some of the physiographic features which exercised a considerable effect on the progress of exploration, little as the explorers themselves understood such matters. In the first place Canada offers a rather inhospitable front to the explorer, for the infertile surface of the Great Shield is the dominant feature in the east. Newfoundland is in a sense a corrugated portion of the same sterile unit. The eastern coasts of Nova Scotia are built of rocks almost as ancient as the Shield, and almost as sterile. Gaspé and the extensions of the Appalachians are today almost as empty as they were in the days of the explorers, except for a scattered fringe along the shore itself. After 350 years, even with settlers like the French habitant or the Scots fisherfolk, both fairly satisfied with a low standard of living, only Prince Edward Isle and the Eastern Townships offer any large areas of reasonably dense settlement in the far eastern part of Canada. Folk travelling today along the Gulf of St. Lawrence see farms along most of the shore-line, but do not realize that this is a strand-line of settlement. It was soon occupied, and no important expansion to the hinterland has been found possible. Consider for a moment the site of Shelburne on the east coast of Nova Scotia. Here 10,000 fairly well-endowed Loyalists landed in 1784 expecting to found an important city. Today only scattered farmers and fishermen

[1] 'History of Exploration in the Canadian Arctic', by P. D. Baird and J. L. Robinson, *Canad. Geog. Jnl.*, March 1945. This article gives two good maps of recent surveys, and interesting photographs.

remain; the environment having been too inhospitable for the growth of an important population, though for a short time it was the largest settlement in British North America!

The first real attempts to settle Canada took place on the western shores of the Bay of Fundy, just where later the boundary was drawn between Canada and the United States. The great French leader Champlain was one of the chief promoters of plans for settling New France. He made various voyages and tried out numerous sites, before he finally chose Quebec for his permanent headquarters. In 1604 some houses were built on a St. Croix isle near Maine, chosen mainly with an eye to defence against Indians

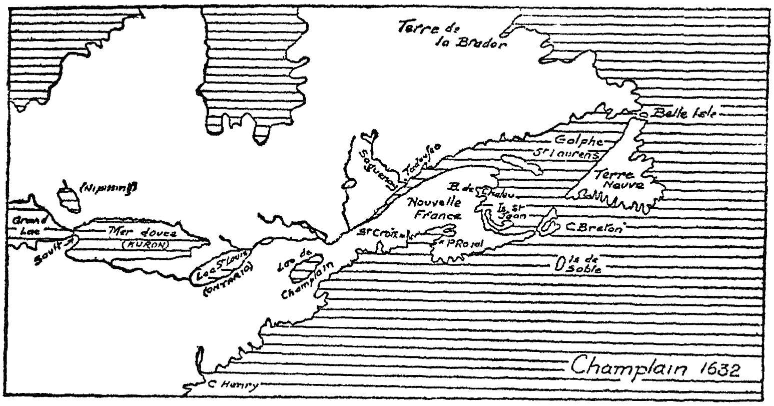


FIG. 8.—A contemporary map by Champlain published about 1632, showing Tadoussac, and the lakes as far as Superior. Note the absence of L. Erie. (St. Croix and Port Royal added)

(Fig. 8). But next year the settlers moved across the bay to the sheltered harbour at Port Royal (now Annapolis). Here the sea has breached a long ridge of Triassic lava (North Mountain); and drowned part of the broad vale of soft Triassic rocks which lies just to the east of the lava ridge. Today this long narrow vale of softer rock and fertile soil is one of the best orchard districts in the Dominion (Fig. 44). But Annapolis has not developed into the chief town of the region; and is, today, a small settlement chiefly visited by tourists to inspect the remains of the old fort. Port Royal was abandoned by the French in 1607, though Lescarbot had made fair progress with farming near the fort. It is worth repeating some words of this wise pioneer, spoken in a century when most explorers hoped for riches of gold and silver rather than for land suited for agriculture. He writes: 'The first and most essential mine is to have plenty of bread and wine and cattle. Our happiness

does not spring from mines of gold and silver, which cannot employ men either at tilling the soil or at manufacturing.'

Tadoussac at the mouth of the Saguenay was perhaps the chief trading post of the cod-fishers on the St. Lawrence at this date (Fig. 8). The French colonists, however, pushed west to the narrowing of the river at Quebec, and here Champlain founded the first permanent town on July 3rd, 1608. He built a quaint wooden chateau called a 'Habitation', in which his workmen occupied the upper floor. A separate dovecote was one of the most prominent features of the building. Here he soon came into conflict with the strongest Indian tribes, the Iroquois. These comprised the Five Nations, linked in a military confederacy, who dwelt along the south shore of Lake Ontario. They were enemies of the Hurons and Algonquins of the north, who had made friends with the French; and Champlain agreed to help the northern tribes.

The chief corridors of migration south-east of the lakes bordered the ancient dome of the Adirondacks. To the south was the Mohawk Gate, to the east was the Lake Champlain Gate. These two routes met near Albany; later to become the capital of the State of New York. In 1609 Champlain and his Indian allies moved south to attack the Iroquois, along the lake which has ever since been known by his name. Next year Champlain again attacked the Iroquois at the north end of the Lake Champlain Gate, at Sorel not far from Montreal. As a result of these battles the French earned the undying enmity of the Iroquois, who became allies of the British in the struggles of the next century.

In 1613 Champlain explored the Ottawa River, hoping that it would lead him to the 'Northern Sea'; and two years later he made his longest journey up the Ottawa, across Lake Nipissing to Lake Huron. From here he sailed down the lake to the region around Lake Simcoe (Fig. 9).

He soon joined the Hurons for another raid on the Iroquois. On this journey he discovered Lake Ontario, which he crossed in the vicinity of Kingston. Thereafter he spent most of his time at Quebec and did little exploring. One of his men, Étienne Brulé, in the same year explored the region near Toronto, Niagara, and Lake Erie; but we have no accurate account of his interesting journeys. In 1634 Jean Nicolet travelled far to the west and discovered Lake Michigan and Green Bay. Indeed, he almost reached the Mississippi at his farthest western limits. Two intrepid priests, Dollier and Galinée, about 1670 explored most of the unknown shores of Lakes Ontario, Erie, and Huron, and reached as far as Lake Superior (Fig. 9).

The best-known French explorers were those who turned to the south-west and opened up the great valley of the Mississippi. La

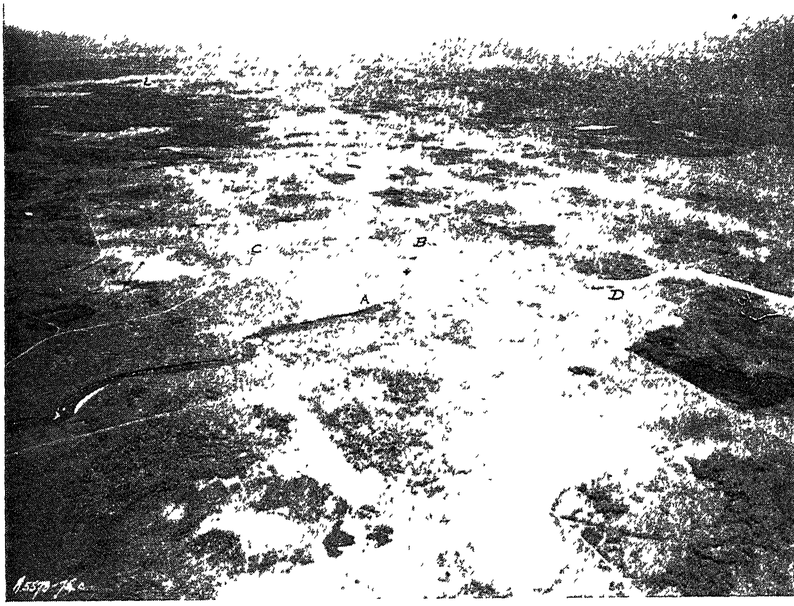


PHOTO 3.—THE CLAY BELT AT KAPUSKASING

PHOTO 4.—LAKE OF THE WOODS ON THE SHIELD AT KENORA

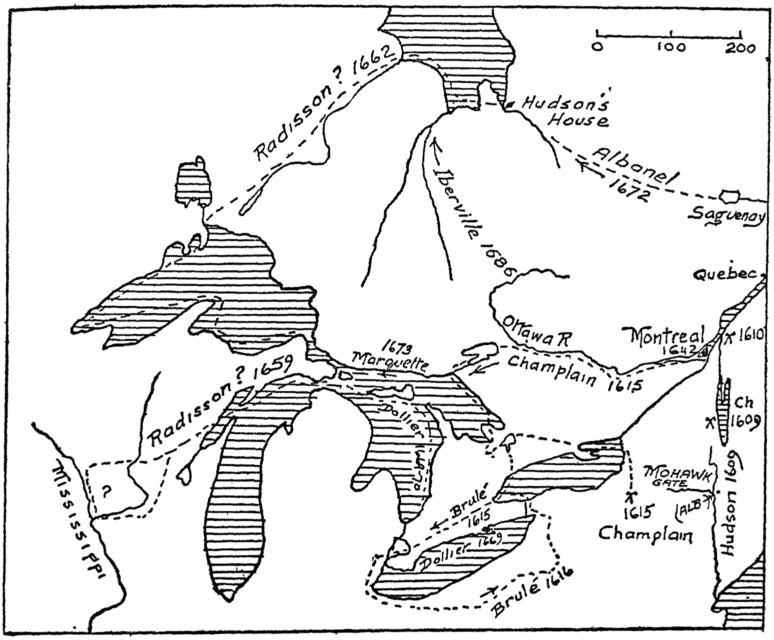


FIG. 9.—Explorations of the French between 1610 and 1686

Salle was granted the manor of Lachine near Montreal about 1666, and was the first man to place a ship above the Falls of Niagara. In 1679 he sailed the *Griffon* from near Niagara to the south end of Lake Michigan. Marquette and Joliette were also concerned with explorations outside the Dominion.

Perhaps the most romantic name in the whole of Canadian history is that of Pierre Radisson. While quite a young man he had been captured by the Iroquois, but he managed to escape to the Dutch settlements on the Hudson River. He became a fur-trader, and joined Grosseiller at Three Rivers about 1659. The two men reached the Great Plains to the west of Lake Superior; but as is so often the case we have no accurate knowledge of their wanderings. In 1662 they were far to the north-west, and described their wanderings near a great lake. It is not certain whether this was Lake Winnipeg; but there was no doubt concerning the great store of beaver skins which they brought back to Quebec. Burpee [1] suggests that a phrase in Radisson's account: 'We came to the seaside, where we find an old howse all demolished and battered with

[1] L. J. Burpee, *An Historical Atlas of Canada*, Toronto, 1927. This is a very useful collection of maps—largely dealing with battlefields—with concise notes.

boullets', may possibly refer to the house built by Hudson in 1610 at the south of James Bay. Hence they seem to have reached James Bay from the south-west (Fig. 9).

The two Frenchmen were scurvily treated by the French rulers in Canada, and after futile attempts to take a ship into Hudson Bay they sailed to England, and enlisted the aid of King Charles II. In 1668 they sailed in two ships for the fur country. Money had been subscribed by many eminent Englishmen, including Prince Rupert, the Duke of Albemarle, Lord Ashley, and others. Charles gave the resulting company full rights over all the coasts of Hudson Bay; and ultimately this was interpreted to mean most of Canada, and indeed some part of modern Oregon.

In 1668 Grosseiller sailed from England to Hudson Bay, and brought back such a valuable load of beaver skins that there was little difficulty in forming a company in 1670 to exploit this part of Canada. The famous Hudson's Bay Company is probably the oldest firm of its kind in the world, and still has trading posts, as well as huge department stores, in many parts of the Dominion. In 1672 the French awakened to the danger of a powerful English Company on their northern boundary, and sent Albanel from Saguenay to James Bay, where he proclaimed this region part of the French Dominions. In 1686 Iberville, marching north from Montreal, captured three of the British forts (Fig. 9).

The chief centre of the great company was at York Factory on the Nelson River, and as early as 1689 Kelsey was exploring the barren lands to the north. In 1691 he made a lengthy journey to the south-west and probably reached the basin of the Assiniboine far beyond Lake Winnipeg. Meanwhile, Radisson had gone over to the French, and fought the ships of the Company in the vicinity of York Factory. Later he changed sides again, and received a pension from the Company about 1710.

For a decade there was war in Hudson Bay, between the Company and the French led by the intrepid Iberville. At the Peace of Ryswick in 1697 only two forts, Albany and New Severn, remained in English hands. But the later wars in Europe terminated in favour of the British, and at the Peace of Utrecht in 1713, the captured forts were restored to the Company.

For a time Rupert and Severn were abandoned, but the log forts at Moose River, Albany, Nelson (York), and Churchill were now improved, and constructed in part of stone. Many of the Company servants were recruited from the north of Scotland, among them being various Belchers and Mackenzies whose names became famous in Canada (Laut). The Company was still keenly interested in the possibility of a sea route to China, and in 1719 Knight was sent to Churchill with orders to sail north on this quest. His whole

expedition perished through starvation on the west side of the bay.

The French having lost their position on the bay turned to the corridor via Lake Superior. Noyon had explored west from the great lake in 1688, while Verendrye had erected a fort on the Lake of Woods about 1732. From this centre he and his sons explored

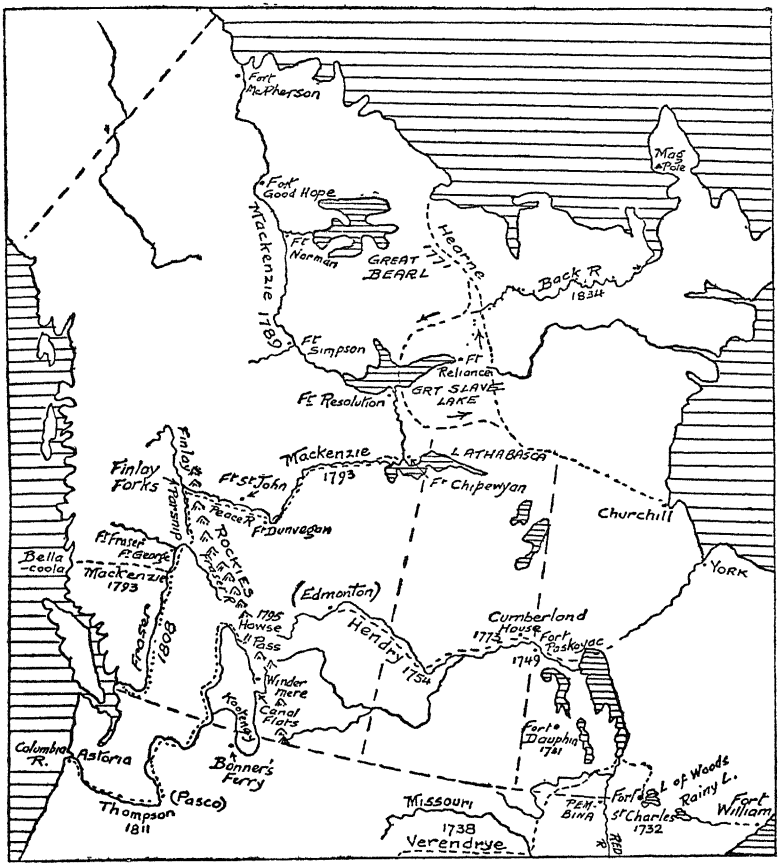


FIG. 10.—Explorations of the fur-traders from 1732 to 1811. The journeys of Verendrye, Hendry, Hearne, Mackenzie, Fraser, and Thompson are charted

to the west. Their chief discoveries were in the United States, where the sons may have pressed beyond the Black Hills, though it is not certain if they saw the Rockies. A lead plate set up by Verendrye on the Missouri River was found in modern times by some children in the vicinity of Pierre. The French now adopted the policy of building a line of forts to cut off the supplies of beaver

brought to the bay by the western Indians. Dauphin was built in 1741, Pas-koyac (near The Pas) in 1749, and La Corne farther west in 1753 (Fig. 10).

A young English smuggler, Anthony Hendry, had taken service with the Company at York. In 1754 he asked permission to travel west with the Assiniboine Indians, who had brought in their usual catch of beaver. We have no accurate knowledge of his journey, but in the east he used a route which was a canoe highway for a century later. The Indians paddled up the Hayes River, and then across the Nelson to The Pas (i.e. Pasquia). Near this point he met some of the French traders, but he pushed on to the west and soon reached more open country with many red deer. Later in his journey he found that the Indians were riding horses, which were descended from stock introduced into America by the Spaniards. By the end of October Hendry was among the Blackfeet Indians in the vicinity of modern Edmonton. From here he returned next spring with the Assiniboines, picking up cargoes of furs from the Blackfeet Indians *en route*. The French, however, took toll of the best furs as Hendry passed through their territory. He reached York on the 20th of June 1755, after being absent exactly a year (Fig. 10).

As the French increased in numbers in the west, in part owing to the British Conquest in 1763, they came more and more into contact with the Western Indians. We may profitably digress a moment to consider the life of these Indians. In the Plains it centred largely about the herds of buffaloes; while to the north of Lake Winnipeg their culture depended mainly on the moose and caribou. The buffalo seem to have moved usually in two great herds. One of these grazed near the southern Red River area in winter, and then moved westward towards the Black Hills in the summer. The larger herd moved south in the spring from the Qu'Appelle basin, and up the Missouri valley. They gradually turned north towards Lethbridge, and then reached their winter feeding grounds by way of Saskatoon. The Indians with their primitive weapons were not much of a menace to these gigantic herds. The wolves took toll of the calves, but could not greatly harm adult buffalo. All this was greatly altered when the Indians obtained horses and guns.

The Snake Indians of the Lethbridge area were some of the first to obtain horses, perhaps about 1730. We know that Verendrye saw Indian horsemen about 1738. But the Crees of the Winnipeg area bartered furs for guns before most of the other tribes. With these powerful weapons they moved against the Blackfeet of the west. Soon the fur traders came to depend on the buffalo for their meat supplies, while the robes found a ready market in the States.

About 1840 these buffalo hunts were still in vogue. As many as 400 men would set out to meet the buffalo, and exterminate the huge creatures for the sake of their robes. Often nothing but the tongue was used as food. Within forty years the herds had vanished, mostly due to the wasteful hunting, but partly perhaps due to the terrible winter of 1880. Some of the last survivors were shot near Calgary in 1881.[1]

As the Frenchmen gained more and more power in the Prairies, the Hudson's Bay Company decided to explore the lands still untouched to the north. Chippeway Indians came to their forts bearing crude ornaments made of native copper, which they had obtained from a river far to the north. In February 1770 Samuel Hearne started from Churchill to find the copper mines, and with luck to open up new fur country for the Company. His first journey resulted in the exploration of the region round Dubawnt Lake (Fig. 10). He was able to kill enough caribou for his food supply, but had to turn back without finding the copper mines. In December he was off again, assisted by the Indian Matonabbee, and in mid-June he reached the valley of the Coppermine. Here the Indians fell upon a camp of sleeping Eskimos, and slaughtered the whole party, taking their collection of furs. Nearby Hearne found some fragments of copper, and then the whole party retreated to the rich hunting-grounds of the Lake Athabasca. Here moose, beaver, and buffalo, were all to be found; and here many of the Indians made their winter camps. Next spring Hearne canoed down the Churchill River and reached the fort on the 30th June.

In 1773 Hearne was sent west to establish Cumberland House in an effort to combat the French 'Pedlars' on their own ground. One of his colleagues, Matthew Cocking, had just set out on a tremendous journey which rivalled that of Hendry in 1754, and covered much the same ground. He reached the Bow River, and brought back a description of the complex culture of the Blackfeet Indians in that part of Canada. They spent their life hunting or raiding the Snake Indians for horses. Cocking persuaded them to sell their furs to the Company rather than to the French interlopers. In 1795 Howse was exploring the Rockies near the pass which bears his name, and in 1799 a fort was established on Lake Athabasca.

Meanwhile the interlopers from Montreal, now under the English flag, were organizing. In 1766 Curry had made the canoe journey from Montreal along the route already described as far as the forks of the Saskatchewan. He collected furs which gave him \$50,000. Frobisher and McGill formed a company which set up stations for trading at dominant points. One such was at Frog

[1] *Under Western Skies*, A. Morton, Toronto, 1937. A good popular account of early life on the prairies.

Portage, so-called because of an Indian joke referring to a stretched frog-skin. Yet farther north was Fort à la Crosse, whose name was derived from the Indians' game of lacrosse (Fig. 11).

This group of Montreal fur-traders was soon united as the North-West Fur Trading Company. The stockholders who supervised the trade in the fur country were called the 'wintering partners'. A 'Little Company', containing MacKenzie and Findlay among others, took the field in opposition to the Nor'westers. The rivalry was bitter, especially in the north. Pond of the Nor'westers was the first trader in the Athabasca region, but Ross from the rival company practically sat on his doorstep. Pond had

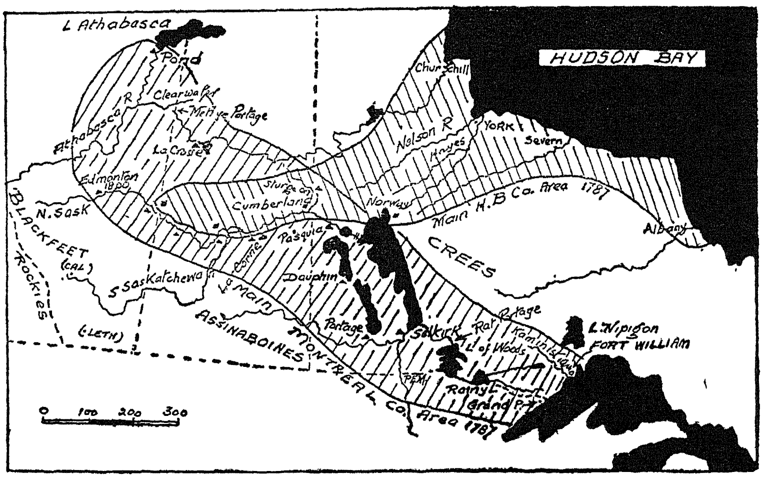


FIG. 11.—The rivalry between the Hudson's Bay Company and the Montreal fur-traders up till about 1787 is charted

already murdered one man, and it is surmised he now shot down Ross. However, he remained free, and later retired to Boston. The two Montreal companies merged into one in 1787.

Rivalry with the Hudson's Bay Company continued for thirty years. The western headquarters of the North-West Company was set up at Fort William in 1800, and named in honour of William McGillivray. They also pushed into the Nipigon country which lay between the Hayes River and the Abitibi. The best portage from Lake Superior was at Grand Portage in American territory, so that another route leading up the Kaministiquia near Fort William came into general use (Fig. 11). Here about ten portages in 4 miles brought the canoes to the main divide. Then to the west there were ten small lakes with eighteen portages to be negotiated which led them to Lake Lacroix. From here, four more portages gave them access

to Rainy Lake. After Lake Lacroix the route was the same as that followed by the voyageur on the Grand Portage route.

There were Nor'wester posts from Pembina in the south-east as far as Edmonton in the north-west. The latter post was opened about 1800, right in the midst of the region where Blackfeet fought with Cree (Laut). Another important post of the Nor'westers was built next to the Cumberland House of the Hudson's Bay Company. The younger company had many other posts along the North and South Saskatchewan Rivers, such as Fort Pitt, Fort George, Fort Vermilion, while Upper Bow Fort was placed close to the modern town of Banff.

Meanwhile, Alexander Mackenzie had taken Pond's post on Lake Athabasca, and in June 1789 he travelled north along the Slave River, so-called because the Crees drove the weaker Indians out of the south. The explorers were lost for three weeks on the waters of Great Slave Lake, but finally found the outlet at the north-west corner. Early in July they passed the outlet of Great Bear Lake, and an Indian told them that the sea was only ten days' journey to the north. On the 14th July Mackenzie reached the waters of the Arctic Ocean, which had, however, been seen by Hearne far to the east in 1771 (Fig. 10).

In 1798 the first settlement in what is now British Columbia was made at Rocky Mountain House, about 12 miles above Fort St. John on the Peace River. In May 1793 Mackenzie set out from the forts on the Peace River on his famous journey to the Pacific (Fig. 10). He was spurred on by the hope of opening up the western coasts before his rivals in the Hudson's Bay Company, and before the American Company under Astor, had reached as far west as the Columbia River. Mackenzie discovered that the juvenile canyon of the Peace River, where it cuts across the main Rockies, was quite impassable; and had to make a portage of 9 miles, which took them three days of incredible toil. They found the 'Forks of the Peace' to the west of the mountains, as described by Indians; and then on the 3rd June turned south (along the great Rocky Mountain Trench) up the Parsnip River. Here they crossed to the Bad River, a tributary of the Fraser, and at last met Indians who traded with the coastal tribes. After many dangerous days on the Fraser, Mackenzie ascended the Blackwater River, which led him to the west, and he reached the Pacific near Bellacoola on 22nd July 1793 (Fig. 10).

The last chapter of major exploration in connexion with the fur trade deals with the opening up of British Columbia. The North-West Company sent two of their officers, Fraser and Thompson, specifically to survey this great territory, and to forestall other companies. Thompson had spent many years along the Inter-

national boundary, which was now being exploited by the Canadian fur-traders. In the winter of 1806 he reached the vicinity of Howse Pass, and in June he discovered the Columbia River near Golden. He turned south and soon arrived at the remarkable divide between the Columbia and the Kootenay, now called Canal Flats (Fig. 10). Near here he built Kootenay House, and then proceeded south down the great 'trench' to Bonner's Ferry in Idaho.

Troubles with the Indians delayed his exploration till 1811, when he placed his canoes on another of the rivers of the great 'trench', i.e. the Canoe River. They reached the Big Bend of the Columbia, and paddled down the river past the site of Revelstoke, and through the Arrow Lakes to the rich mineral region of Trail. Southward he journeyed into what is now Washington; and on July 9th erected a pole (near modern Pasco) claiming the country for Britain and the North-West Company. But when he reached the sea at the mouth of the Columbia on the 15th July, he found that the Americans had forestalled him. Already there had arisen the nucleus of the modern town of Astoria, and Thompson had been beaten by a scanty two months (Fig. 10).

Meanwhile, Fraser had ascended the Peace River, and placed a fort at Finlay Forks in 1805. Next year he followed Mackenzie's route, and reached the junction of the Nechako with the Fraser (now Prince George). He pressed on to the west and built Fort St. James, Fort Fraser, and a little later Fort George. Towards the end of May, Fraser launched his canoes on the big river, which he believed to be the Columbia, and journeyed southward on the Fraser River. At Cottonwood Canyon and again at the rapids below Soda Creek it was necessary to portage. On June 20th they reached the junction (now Lytton) with a big river, which Fraser named the Thompson after his explorer friend. At the dangerous rapids near Yale they portaged again, and reached Spuzzum on June 26th. By the 3rd July they knew that the river was not the Columbia, since they reached tidal waters far north of Astoria. Here Fraser turned back, since hostile Indians barred the last section of the Fraser River. As Agnes Laut comments in her graphic description of these explorations: 'In thirty years the *Pedlars* (as the English called the Nor'westers) had explored from Lake Superior to the Pacific, from the Missouri to the Arctic.'

Brief mention must be made of the incidents which led to the amalgamation of the Hudson's Bay and the North-West Companies. In 1807 Lord Selkirk, a young Scottish nobleman, married the daughter of one of the largest shareholders in the Hudson's Bay Company. He was interested in settling poor Scottish folk in the new lands across the sea, and he countered the objections of the fur-traders to an influx of settlers by buying a controlling interest

in the great company. The emigration which he sponsored is described elsewhere (p. 318).

The North-West Company opposed Selkirk to the utmost, and in a skirmish at Seven Oaks near Winnipeg in 1816 a number of Hudson's Bay officers were killed. However, after some years of violence the two companies agreed to merge their interests. In 1821 Nicholas Garry was sent to rearrange the administration of the combined company, and the fort at Winnipeg bears his name. There were at this date about 200 Scottish immigrants and 200 other settlers in the Red River area. Further details of the gradual occupation of the Dominion will be found in the chapter 'Spread of Settlement' (p. 307).

A great advance in our knowledge of Arctic Canada has followed the use of aeroplanes for surveying, and the rise in military importance of these lands. Government stations have recently been placed on Ellesmere Island at Eureka Sound on the west coast. Resolute Bay on Cornwallis Island is another station; and a third is being established on Melville Island far to the west. Bathurst Island seems to be really five small islands. High mountains mark the north of Ellesmere Island. An island 70 miles wide has been observed from the air in the north-east of Foxe Basin. The new position of the Magnetic Pole is described on page 303. (See also J. L. Robinson, 'Western Arctic', *Canad. Geog. Jnl.*, Dec. 1948.)

A. L. Washburn in *Geography in the 20th Century* gives a chapter on 'Geography and Arctic Lands' which is very instructive, especially with regard to methods of exploration, recent research stations, and gaps in our knowledge of the North.

Stressing the resemblances between the Canadian and Siberian Northlands is a paper by Griffith Taylor, 'Soviet and Canadian Settlement', in *Can. Inst. Internat. Affairs* (p. 144), 1946.

CHAPTER III

STRUCTURE AND GEOLOGY

The Evolution of the Build of Canada

AFTER many years of research in geography the writer is convinced that a knowledge of the structure or the build of a country is the best basis upon which to found the discussion of the relation of man to his environment. Man often changes his interests and his ways of exploiting Nature, but the most stable feature in the picture is obviously the build of the region in question. By 'build' I mean the essential geological pattern, whether ancient shield, crustal trough (syncline), or ridge (anticline), raised relic of an '*old*' range, or lastly '*young*' mountain, either with broad or narrow folds.

This aspect of geography has been presented in the better text-books of Europe since 1910, but it is perhaps not quite so generally discussed in America. Its great advantage is that it enables us to account for the distributions of various commodities, such as metals, coal, oil, water-supply, and soils, in a fashion impossible by the older method, which largely ignored build.

Some of us believe that the early geographical teaching which tells us merely the 'how and where' of various products is hardly worthy of the name of a science. But this structural treatment, which often gives us the 'why' of the distribution, is all-important. I propose in this chapter to sketch first Canada's place in the World-Plan; and then to show how 'build' has to a considerable degree determined man's methods of settlement.

The plan of the world in terms of its build is fairly simple. It consists essentially of rigid areas (called *Shields*); of very weak areas which have yielded greatly to folding forces, and so produced 'young mountains'; and of other less-striking elements which have yielded to much less degrees. If we survey the whole land area, we find that the shields in general surround the Atlantic and the Indian Oceans; and that the young mountains surround the Pacific Ocean (Fig. 12). Staub considers the floor of the Pacific a shield.

A useful analogy is to imagine that the crust of the earth is like a rubber balloon, of which large areas have been varnished. As the balloon shrinks (through slight deflation) the varnished areas (i.e. the shields) remain rigid; but the weaker unvarnished portions are puckered into many ridges. The latter represent the 'young' mountains. Possibly the floor of the Pacific Ocean (especially in the eastern portion) is the most important unit in the earth's crust,

and is a huge unyielding area like a gigantic shield. The occurrence of major wrinkles all round it (Fig. 12), separating the Pacific area from the smaller shields of Canada, Brazil, Antarctica, Australia, and Siberia, certainly indicates that the weaker areas have been compressed between the gigantic Pacific Shield and the smaller continental shields. Even as regards Antarctica, the writer suggested this possibility in 1913. Ellsworth in his flight in 1935 discovered what seem to be young mountains folded against the South Polar Shield, just where the general theory suggests (Fig. 12).

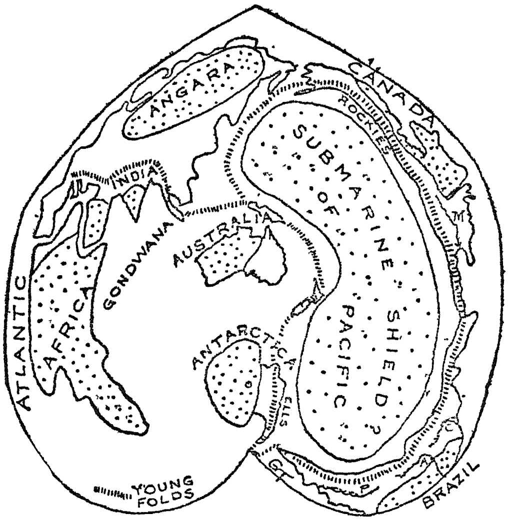


FIG. 12.—The build of the world, indicating the division of the crust into resistant Shields (dotted) and young mountain folds (broken lines). The latter have been squeezed between the Shields. Thus each continent, including Antarctica, has much the same build. ('Ells.' indicates Ellsworth's polar flight)

It follows from the above world-plan that all the continents consist of three major regions. The shield lies on the Atlantic side, the young mountains on the Pacific side. There is a less definite area between these two which usually takes on the shape of a broad crustal trough or syncline. This is definitely the pattern in Canada, and each of these three types has its special economic characteristics.

Since many of my readers may not have been trained in geological technique it will not be out of place to discuss in general terms the process of mountain-building. It is illustrated in a simplified form in Fig. 13. It is a curious fact that most of the high mountains of the world have been built of sediments laid down rather recently.

On the edges of old continents, the debris laid down by the rain and rivers is deposited in great belts parallel to the coast. This process of *sedimentation* is shown in vertical section in Fig. 13. It may be that after many million years the crust becomes overloaded here. At any rate after a long rest—usually about 150 million years—the earth enters on a period of stress and strain. The crust yields beneath the young deposits, and is squeezed into folds between the shields (Fig. 13, middle). Often some of the deep-seated crust is involved in the giant folds, which may extend for several miles

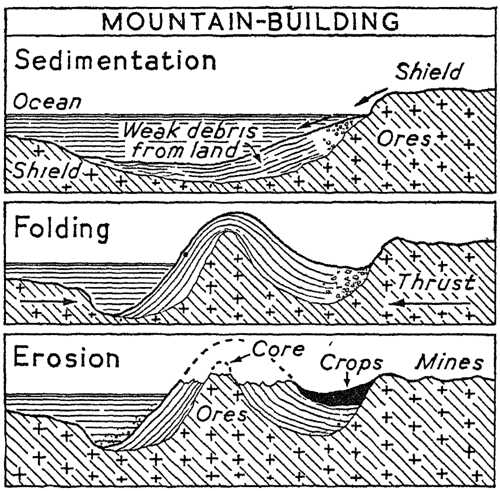


FIG. 13.—Three vertical sections through a part of the earth's crust which is undergoing mountain-building. At the top are shown *sediments* washed from the continent (at right) into the sea. In the centre *earth-folding* is suggested. At the bottom *erosion* has exposed the ancient core-rock, and washed soil (black) into the shallow downfold on the right. (*Canad. Geog. Jnl.*, 1937)

downward. During this process of folding the two shields draw nearer to each other, in some cases moving through many miles, as is roughly indicated in Fig. 13.

A universal feature in mountain-building is that these great ridges (anticlines) are rapidly attacked by rivers and rain. Mountains generally receive heavy rainfall. The velocity of their steep streams is great, and their erosive power much magnified in consequence. Hence we find the mountains rapidly worn away by *erosion* in the manner sketched in the bottom section (Fig. 13). It seems likely that this wearing away is accomplished in 20 million years or so. A study of the long geological record, which goes back with some accuracy to Cambrian times (about 500 million years ago), seems to

show that low uniform landscapes, i.e. plains and worn-down mountains, have on the whole been much more typical of world geography than are the young mountains of today.

We are, in fact, living at the close of a great period of environmental change, lasting for some 20 million years, which geographers term the period of the ' Alpine Storm '. Before that time, throughout Mezozoic time, a matter of a 100 million years, the crust exhibited its more usual state of ' quiescent peneplains '. Back of this was the ' Armorican Storm ', about 150 million years ago in the Permian, preceded by the calm period of the Carboniferous. Earlier again, about 300 million years ago was the ' Caledonian Storm ' of early Devonian times, which followed on the period of peneplains and great drowning of the continents which marked the Silurian and Ordovician times. The tremendous crustal stresses of early Cambrian times, about 150 million years earlier than the ' Caledonian Storm ', have not been specifically named I believe.

As a result of the erosion of the young mountains illustrated in Fig. 13 (bottom), the core of the mountain is made apparent, when its covering of younger rocks is removed. This core often contains metals derived from deep-seated sources in the crust. In the second place, the debris is washed into the sea on the seaward side, and into nearby depressions (often a complementary downfold) on the landward side. Thus large areas of good soil are accumulated in the shallow downfold. This depression naturally controls the courses of the large rivers, as for example the Mackenzie and the Mississippi in North America. The Amazon and Parana have a similar position in South America (Fig. 12). Thus we have already learnt of a valuable correlation between build, metals, rivers, and crops.

As stated earlier, we have a pretty good idea of earth history and geography for the last 500 million years. We also know that mountains cannot be called ' old ', in the sense that shields or even rivers are ' old '. It has been suggested that some rivers have had much the same course for 200 million years, but mountains wear down relatively quickly, and possibly no mountain lasts more than 30 million years, unless it is again uplifted. Hence a *high* mountain range is necessarily a ' young ' mountain, and is usually less than 20 million years old.

Let us now study the past geography of North America, as the findings of the geologists show it to us. The long record of the rocks is indexed for us by the fossils found therein. But of late years the actual age of the rocks in years has been determined approximately by the alteration of certain radio-active minerals in them. These ages are indicated in the diagrams. In Fig. 15 are shown two stage-diagrams (each of four maps) dealing with most of the continent. In these maps the present coastline is indicated by a

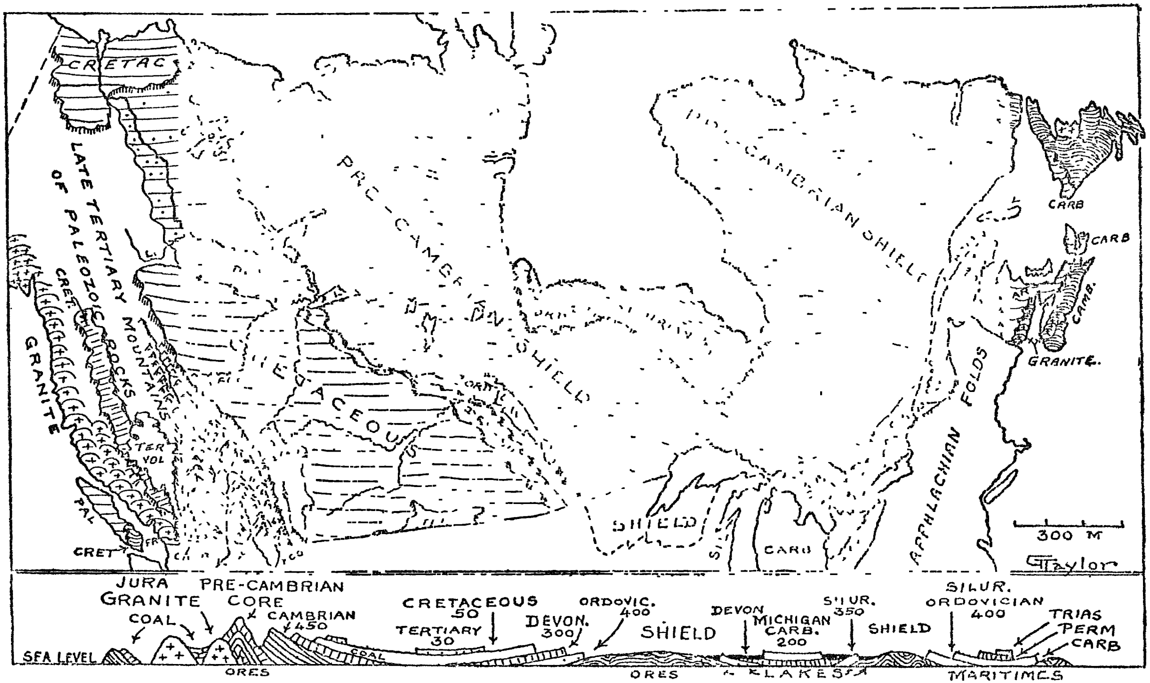


FIG. 14.—A Mantle-Map of Canada, in which the later geological formations are shown as mantles flung over the older formations. Below is given a simplified geological section near the southern border of Canada. Figures mean millions of years ago; Lakes Michigan and Huron are shown black. (*Canad. Geog. Jnl.*, 1936)

broken line. Of course, in such maps any lands indicated *outside* the present coasts of the continent are largely hypothetical. The maps are based on data given by Chamberlain and Salisbury (*Geology*, N.Y., 1928). It will be noticed that the north-east corner of the continent has been unaffected by the ups and downs of continental evolution. This is the area of the Shield, and its character may well be discussed first.

The great Canadian Shield extends from the Arctic Ocean near the Great Bear Lake to the United States border near Lake Michigan (Fig. 14). It comprises more than half of the Dominion, and its western boundary is clearly marked by a series of immense lakes. Most of these, perhaps excluding Lake Superior, are cuesta lakes; i.e. they are in part determined by the *edges* of younger strata dipping to the west from the old continental mass of the Shield. South of the Great Bear are the Great Slave and Athabasca Lakes. Then comes a curious string of narrow lakes along the course of the Churchill River, which lies just along the edge of the Shield. From Wood Lake eastward to the new railway to Port Churchill is another string of lakes along the cuesta, which emphasizes the boundary of the Shield almost to Lake Winnipeg. This huge lake occupies the hollow along the margin of the Paleozoic strata of western Manitoba, and much of its floor is formed of the granites of the Shield. South of Lake Winnipeg there seem to be no cuesta lakes marking the boundary of the Shield as far as its extreme south-west corner. Here is the remarkable Traverse Lake which actually forms the 'valley-divide' separating the Red River from the Mississippi. It is not clear, however, that there is any connexion between the edge of the Shield and the former channel of the Red River (Fig. 16). There are no cuesta lakes from Traverse Lake eastward to Lake Winnebago, where the edge of the Shield runs north–south reaching Lake Superior at Marquette.

The eastern end of Superior appears to be determined in part by the Cambrian cuesta. Georgian Bay is definitely dammed on the west by the dominant Silurian cuesta, which runs continuously from Albany (N.Y.) to Chicago, and is responsible for Green Bay and Manitoulin Island also (Fig. 14). Lake Ontario is another cuesta lake due to the great Silurian Scarp; but complicated faults and *graben* seem to be responsible for the St. Lawrence valley below the Frontenac anticline near Kingston. This latter feature produces the granite dam across the big river, where the shallow waters pass between the Thousand Isles, so well known to tourists.

To the east of Quebec the waters of the gulf wash the edge of the Shield, though a little Paleozoic rock appears on the shores opposite the Paleozoic Island of Anticosti. At its south-east corner the Shield is found forming the surface in much of Newfoundland.

The more resistant parts of Cape Breton and Nova Scotia are also formed of surface rocks which are Pre-Cambrian in age, and so belong to much the same period as does the Shield.

In a text-book of geography it is not necessary to detail the subdivisions of the Pre-Cambrian rocks of the Shield. Coleman and Parks in their *Geology* (Toronto, 1922) give the following divisions; and I have added the typical localities, and some of the economic features. The oldest formations appear, as is logical, at the foot of the table. (See also Fig. 16A.)

PRE-CAMBRIAN GEOLOGICAL FORMATIONS

Name	Formation	Place and use
Keeweenawan	1,400 feet of sediments, 16,000 feet of lavas	Great Slave Lake, north-east Superior with copper
Animikie	10,000 feet of slates, &c.	Thunder Bay, Sudbury with iron
Huronian	15,000 feet Quartzites	Cobalt, Steep Rock with iron
Algoman	Intrusive granites, &c.	Porcupine Goldfield
Sudburian	Schists and Quartzites	Sudbury, Lake of the Woods
Laurentian	Oval batholiths of granite with north-east axes	Vast areas through the Shield
Grenville	Limestone in troughs	Georgian Bay to Three Rivers
Keewatin	Basic lavas of same age as Grenville	Michipicoten, Sudbury, &c.

We may start our survey of the paleo-geography of Canada with the diagram appearing at the bottom, left, corner of Fig. 15. It gives a generalized view of the North American continent about 430 million years ago. We cannot do more than show approximately which was land and which sea. Clearly most of North America was a vast sea receiving marine deposits, with land more or less near the present coasts. These marine strata have since often been elevated above sea level. In eastern Canada formations of this age fringe Nova Scotia on its east coast. They are mostly sandstones, which are auriferous in places. Somewhat younger beds of Cambrian age occur along the north shore of Gaspé, and especially to the south of Ottawa near Perth. Some of these outcrops are shown black in the diagram. In the Rockies, however, is a grand series of Cambrian rocks, in places over 18,000 feet thick. Many of the highest peaks near Lake Louise are entirely built up of such rocks.

The second diagram in Fig. 15 shows us the wide extent of Ordovician Seas about 400 million years ago. In eastern Canada the elevated marine Ordovician strata lie more or less conformably over the Cambrian, but are of rather wider distribution. They

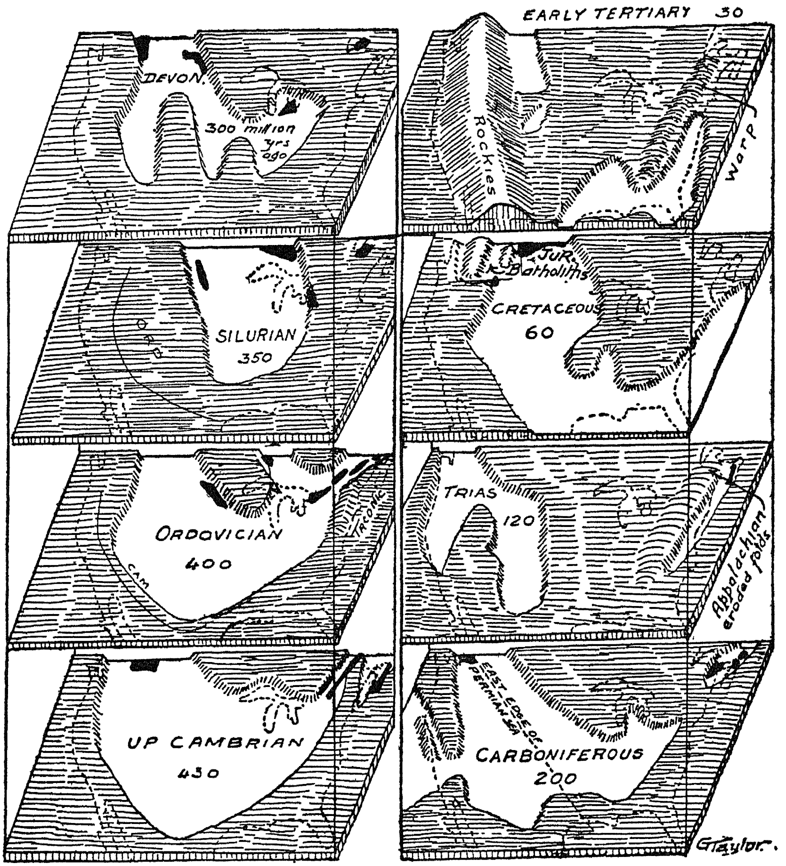


FIG. 15.—Two stage-diagrams which indicate the past geography of Canada and the U.S.A., the present coasts being shown by broken lines. On the left are four maps indicating conditions from 430 million years ago (Cambrian) up to Devonian times. The chief Canadian areas now outcropping are shown as black patches. Schuchert shows land south-west of Kansas in early Paleozoic. (Partly from data in Chamberlain and Salisbury)

cover most of the long narrow rectangle extending between the Niagara Cuesta near Toronto, along the north side of Lake Ontario to the borders of Maine. They are also found on the edge of the Shield south of Hudson Bay; in a similar position near Lake Winnipeg; and in the central area of the Rocky Mountains.

A considerable period of mountain-building ensued in the east, which raised the Taconic Mountains shown in the map of Ordovician times (Fig. 15). In the following Silurian times, about 350 million years ago, marine deposits were laid down in the seas illustrated in

the diagram so labelled. Since those distant times many of these rocks have been raised above sea level. If they are not covered by other deposits—and this is of course usually the case—then they appear as outcrops on the surface. The most important of such outcrops are in the vicinity of Niagara, where they build up the most striking cuesta (or scarp) perhaps in the world. It is the flow of the lake waters over this hard cuesta which has produced Niagara Falls. Other outcrops of Silurian rocks accompany the Ordovician and Devonian strata to the south-west of Hudson Bay; in the south-west of Lake Winnipeg; and again along the edge of the Shield in the vicinity of the great Tundra lakes described above.

Devonian times were marked by the emergence of lands, and by the production of high mountains in many parts of the world. Not much of the North American continent was under the ocean at the beginning or end of the epoch. But in the *middle* period, large areas of marine formations were laid down. The most important in Canada perhaps are those in the extreme south-west of Ontario, between Georgian Bay and Lake Erie. Other outcrops occur where they are indicated in the appropriate diagram (Fig. 15). It was a great period in animal and plant evolution. Huge fish dominated the seas, but plants were now beginning to spread over the lands, and probably insects flew amid the plants.

In Carboniferous times there was an invasion of the continent by the ocean, after the widespread emergence of Devonian age. Much of the centre of the continent received marine deposits; and in places peat beds formed, which later became the best coalfields in the world. In Canada the chief coal-producing beds are found in the Maritimes, in a series of small basins around Sydney, Pictou, and Joggins. In the southern Rockies there are 4,000 feet of limey sandstones, and along the Pacific coasts are 9,000 feet of similar rocks. Unfortunately the conditions did not lead to the production of peat beds, and there is no workable coal in the *western* Carboniferous formations.

In Permian times, about 150 million years ago, there was such a period of emergence that all the continent became dry land. It is thought, however, that the red sandstones of Prince Edward Island, which give rise to better soils than those of greater age in the adjacent mainland, belong to Permian times. Hardly any fossils are found for this period, but from other data we know that this great age of mountain-building produced the Appalachian Mountains to the south of the Taconic Range of early Paleozoic age.

No map of Permian times is given in Fig. 15, but the worn-down Appalachians are suggested in the next map—that of Triassic times. In this period, also, much of the continent was above the sea; but a number of depressions appeared in the east, of the type called

graben. These were accompanied by the outpouring of masses of lava. The most interesting region in Canada with Triassic rocks is the west of Nova Scotia. Here the 'North Mountain' is a sill of basic lava of Triassic age, and along its eastern edge runs the long narrow Cornwallis Valley, where grow some of the finest apples in the continent.

During these later geological periods of the Mesozoic, it is to be noted that there is a large elongated trough in the region now occupied by the Rockies. This is a *geo-syncline*, in which vast deposits of sediments took place during the Triassic, Jurassic, and Cretaceous times. Elsewhere there was very little deposition during this long period, say from 20 to 30 million years ago. But one of the most important mountain-building periods in Canada occurred at the close of Jurassic times. Vast masses of granite welled up in the west of British Columbia, forming *batholiths* which probably did not reach the surface. Thus originated the Coastal Ranges and the Selkirks.

The widespread Cretaceous Sea is indicated in one of the right-hand diagrams in Fig. 15. All over the world the later Cretaceous times were marked by a vast depression of the continents, so that wide beds of Cretaceous shales and sandstones were laid down in the seas. Since this period was immediately followed by the start of the 'Alpine Storm', we find that the slopes of many of the mountains of today are formed of the former 'floor deposits' of the Cretaceous Sea. In Canada almost all the prairie region was once part of the enormous sea. In the Rockies, vast areas of the slopes are built up of rocks of the same age. Much of the coal in the Prairies—constituting one of the larger reserves in the world—belongs to this age. A more detailed discussion of the coal in the Prairies, and of the complicated structure of the Rockies, will appear later in the book.

The Tertiary period, like the Permian, was a great period of mountain-building. The continent took on somewhat of the shape which it now possesses; and the deposits of the Tertiary period during the last 30 million years have usually been laid down in isolated basins. Often these enclosed fresh-water lakes, and in many cases some peat beds were formed. Hence we find coal seams associated with some of these Tertiary strata. The geology is quite complex, since mountain-building was accompanied by volcanic activity, and periods of elevation and subsidence followed rather rapidly, especially in the west. In Alberta and Saskatchewan thick layers of sandstones are found of early Tertiary age. So also at Kamloops (B.C.) shales of Eocene age are said to be 5,000 feet thick. During middle Tertiary times (Miocene) there were vast outpourings of lava, especially near Kamloops. At the end of the Tertiary

there seems to have been a general uplift of about 3,000 feet, which affected much of British Columbia. This caused juvenile trenches to be cut in the bottoms of the river valleys, but these features will be discussed in greater detail later.

This summary of the paleo-geography of Canada [1] must include a brief reference to the effect of the Great Ice Age. Actually there were four or five more or less separate ice ages, perhaps at intervals of about 200,000 years. In each case a great cap of ice covered much of North America, including almost the whole of Canada. There seem to have been three centres from which the ice slowly spread over the land. One of these was in northern Quebec, and this was the chief origin of the ice which so moulded the landscape in the St. Lawrence region. Then there was a second to the west of Hudson Bay which sent ice all over the Prairies. The glaciation in British Columbia developed an ice-cap which was not so continuous as the other two, and which was probably separated from them by the highest ridges of the Rocky Mountains. The extremely important changes brought about by erosion and deposition in connexion with these ice-caps and allied glaciers will be discussed in the appropriate regional studies. It may, however, be mentioned here that these ice ages began to affect Canada about a million years ago. The last important ice age ceased about 30,000 years ago in the southern part of Canada. But of course there are ice-caps still in being in Baffin Land, Ellesmere Land, and in Greenland. Hence we may fairly say that portions of northern Canada are still undergoing all the conditions which produce an ice age.

The Geological Divisions in Canada

The writer has found the usual geological map rather difficult to interpret, even if accompanied by sections. For the convenience of geographical students he has devised the 'mantle-map', which to some extent combines the features of a geological map with those of a block diagram. In these maps by emphasizing the various edges of the formations it is possible to show that they resemble a series of 'mantles' laid one on top of the other over the basal crust. Such a mantle-map for Canada is given in Fig. 14. In some cases the wavy edges actually stand out as cuestas, but in general the edges are not as prominent as the mantle-map would suggest.

There are clearly five main geological divisions in Canada. First, the Pre-Cambrian *Shield* surrounding Hudson Bay is dominant. Secondly there are three undisturbed Paleozoic formations laid down along the south-west shores of Hudson Bay. They may be termed the *Hudson Paleozoics*. Then thirdly there is the rather

[1] The standard text-book is E. S. Moore, *Elementary Geology for Canada*, Toronto, 1944.

complex patchwork of 'mantles', which lie on the western and the northern ends of the *Appalachian Folds*. Here the Cambrian Core is covered with an Ordovician Mantle, and capped by Devonian strata. This division forms the southern shore of the St. Lawrence.

In the Maritimes the essential feature is a basin with a surface mantle of carboniferous rock, which contains much valuable coal. In southern Ontario is a sequence like the Hudson Paleozoics, and indeed it was probably originally joined to the latter. Here the hard Silurian Cuesta forms a scarp which extends from Niagara Falls all round Lake Huron and Lake Michigan as far as Chicago. (Fig. 38.)

The fourth division comprises the *Western Slopes*, i.e. the area between the Shield and the Young Folds of the Rockies. This region consists of two parts, of which the northern comprises the Mackenzie basin (formed of a Devonian mantle), and a later Cretaceous mantle crossed by the Peace and Athabasca Rivers. The southern part is the Saskatchewan basin, almost wholly in the Cretaceous mantle, though the edges (cuestas) of the Paleozoic rocks are exposed near Lake Winnipeg. The outstanding feature of this division, already briefly discussed, is the way in which the cuestas of the younger rocks help to hold up the waters of the huge lakes lying on the Shield (Fig. 14).

The fifth division, the *Young Folds*, is the most complex. The latest folding-forces raised the Coastal Ranges and Rockies in a series of ridges running north-west to south-east. The close-set wrinkles of these folds have determined the curious upper courses of the rivers in British Columbia, such as the Kootenay, Columbia, Fraser, Peace, and Liard. The topography is rugged, and hence very different from the relatively undisturbed rocks in most of Canada.

Large areas in British Columbia are covered with lavas of middle Tertiary age, which are suggested in Fig. 14. A great deal of erosion has removed the upper portions of the folds, so that the older rocks forming the cores of the folds are exposed in many places. It is to be noted, however, that the best ore deposits in British Columbia are associated with the rather late (Jurassic) batholiths of granite, which constitute the Coastal Ranges and the Selkirks. The cores of the Rockies, though ancient, seem to have been free from volcanic eruptions, and unfortunately are not rich in metallic minerals.

The coal in the Rockies of Cretaceous age has been compressed, and so improved in quality, in the small fold-basins in this fifth division. The glaciers of the Ice Ages in the last million years have carved out deep valleys and fiords in this area of Young Folds. Hence, good harbours, but only very small areas of good soil are characteristic of our last division.

The geological section at the base of Fig. 14 is much generalized. It runs along the southern border of Canada. The complex folds in the west are suggested. The vast mass of the Canadian Shield, which of course underlies the younger formations, is seen to contain two major basins (as well as many smaller samples). The vast Cretaceous Basin builds up most of the Prairies and contains much coal. It is capped by smaller patches of Tertiary rocks, which also contain coal of rather poor quality. Near Lake Superior is a wide expanse of Shield where very valuable mines of gold, silver, copper, and iron are being developed. Then to the south-east of Lake Superior is another large basin centred in the State of Michigan.

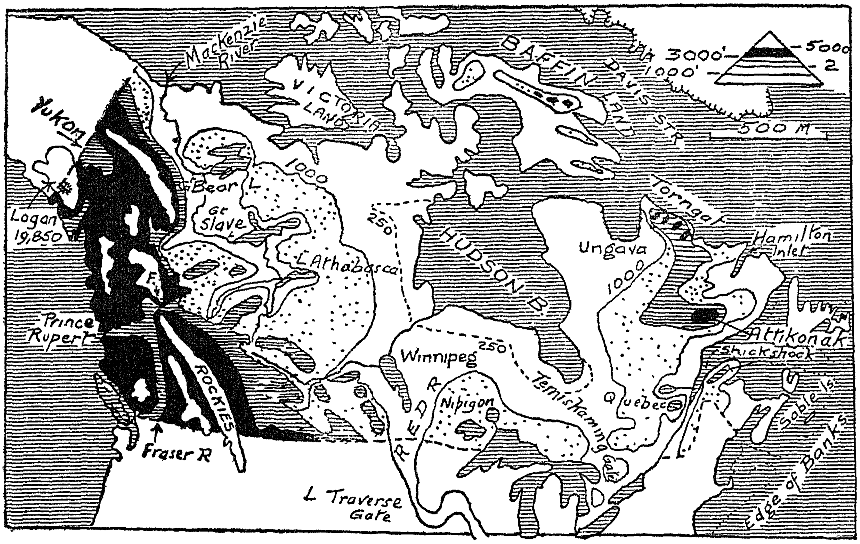


FIG. 16.—The main contours of Canada. Note the three chief 'Gates' out of the northern lowlands; *via* Temiskaming, Red River, and Finlay Forks (F). Heights in feet. See endpaper map for details

As we shall see later the great lakes occupy the cuesta hollows in this basin. (They are shown black in the section.) Another more or less complete basin determines the build of the Maritimes. It is suggested at the extreme east end of our generalized geological section (Fig. 14). The inset in Fig. 38 shows Southern Ontario.

Salient Topographic Features in Canada

The main features of the topography necessarily agree fairly closely with the build. The essential details are given in Fig. 16. In this map the areas over 3,000 feet in elevation are shown black, while those over 2,000 are ruled, and those between 2,000 and 1,000

feet are dotted. Canada in a broad sense may be described as a sort of ' tray ', with the centre flooded to form Hudson Bay. The rim is very broad and high in the west, fairly high in the east, but much broken to the south and especially to the north. Unfortunately the easiest, lowest, outlets are to the north seas, where traffic is negligible; while the easiest land connexions are to the south, to the realms of another nation. However, the main outlets across the south and west are quite significant, and will increase in importance as traffic becomes still heavier.

As we have seen the ' grain of the country, in the west runs from north-west to south-east, and much of the traffic is thereby determined. In the east, although the Shield dominates the build, there is evidence in places of a definite ' corrugation ' in a north-east–south-west direction. This is apparent in the numerous headlands in Newfoundland, and in the direction of the coasts of Nova Scotia and of Gaspé. It is emphasized in the axis of the Appalachians, and also seems to have played a part in the shape of the geological basin which is drowned to produce the Bay of Fundy.

The most remarkable and important break in the ' rim ' mentioned above is the estuary of the *St. Lawrence.* Perhaps no other similar route exists anywhere in the world. The sole other collection of huge fresh-water lakes, those of east central Africa, are not connected to form a similar waterway. It has long been possible to take boats with a draft of 14 feet right to the head of the lakes at Duluth or Fort William. Thus this route offers an ocean highway for 2,200 miles into the centre of a continent; and so it compares favourably with the famous Amazon route, which leads for 2,000 miles into the heart of South America.

The second gap in the rim, which we may call the *Temiskaming Gate*, is a lowland corridor which leads from the St. Lawrence route to Hudson Bay (Fig. 16). It has long been used by Indians and settlers alike, and is traversed today by important roads and railways. The third Gate is occupied by the *Red River*; and, as already mentioned, in the period of the waning of the ice-cap, enormous bodies of water flowed south through this Gate and cut out the wide valley near Traverse Lake. However, little or no water flows in this region today, since the lake is right on the divide. The Red River Gate has been a great corridor for the Indians, and in later years for the large numbers of emigrants and settlers moving into the Prairies from U.S.A. (Fig. 16).

The last low gap is the least known of all, though it is the chief break in the wall of the Rockies. Here the Peace River cuts its way right through the main ridge of the Rockies, having produced a fine example of an ' antecedent gorge '. The Peace River is older than the period of mountain-building; and the river has been

able to cut down its bed at about the same rate as the Rockies have risen across the river. The level of the river here is below 2,000 feet, and is therefore much lower than the other passes, such as Yellowhead Pass which is 3,700 feet above sea level. The settlement just to the west of the gorge is called Finlay Forks (F in Fig. 16), and though it was traversed by Mackenzie as early as 1793, and is a corridor for much of the Peace River settlement, it has not yet truly come into its own. Perhaps it may be overshadowed by the higher but less rugged pass, named after Monkman, which lies a little to the south; just as in the Carpathians and the Alps a smoother if higher pass is preferred to a rugged gorge. A road will soon cross Pine Pass.

However, Fig. 16, though it shows us elevations, gives us very little knowledge as to the character of the mountains and plains. We might reasonably think that the Canadian Rockies resembled in character the fairly high Torngats in Labrador. As a matter of fact, their structure, age, shape, and origin are quite different. So also the region of Ungava (in north Quebec) is clearly a rather low area, below 1,000 feet in elevation. But it has nothing in common with the Red River plain south of Winnipeg, though they look the same on Fig. 16. Again the uplands (shown dotted) south of Lake Athabasca are different from those around Nipigon, and their resources and possibilities of settlement are also quite different. It is this last aspect which emphasizes the necessity of combining a knowledge of the contours with a knowledge of the build. If we compare Fig. 16 with Fig. 14 we find that the examples just quoted offer illustrations of most of the salient topographic features in the Dominion. These are summarized in the following table:

Locality	Type	Height in feet	Origin, &c.
Rockies	Young mountains	7,000 to 15,000	Due to late folding, rugged
Torngats	Elevated shield	2,000 to 5,000	Due to elevation of peneplain
Ungava	Normal shield	Around 1,000	Ancient peneplain
Red River Plain	Normal plain	Around 1,000	Deposited in a silted lake
Athabasca Uplands	Raised sea floor	Around 1,000	Horizontal Cretaceous beds
Nipigon area	Slightly raised peneplain	Around 1,000	Portion of the Shield

A brief reference to the character of the rivers may be made here, though many details will be given in the regional studies. Throughout the Dominion the water-supply is usually adequate. In the north though the precipitation is low, so is the evaporation. In the south-centre, as in the interior of all continents, the summer rain falls off considerably. As a result we have a region between the Missouri and the South Saskatchewan where there are a few

salt lakes ; and where the rivers die away without ultimately entering the sea. But on the whole, the landscape is marked by innumerable rivers, and as far as the Shield is concerned by innumerable lakes. The drainage is extremely juvenile in much of this country, since the debris of the Ice Age was dropped quite haphazardly not many millennia ago, and consequently the rivers have not yet developed a normal branching pattern. Indeed, in some of the lakes such as Athabasca there are two outlets, one leading to the Mackenzie and the other to Hudson Bay. It is this intricate network of rivers and lakes which led to the widespread canoe-travel of the immediate past. The haphazard character of the drainage is also connected with the enormous supply of water-power offered by the innumerable waterfalls. As the rivers cut through the soft glacial debris, they soon reach the granites of the Shield ; so that falls and rapids inevitably develop at the junction of the two formations.

In the more elevated portions of the Shield the ice cut out remarkable cirque valleys, as in the Torngats ; or deep glacial troughs, which were drowned to form magnificent fiords, as in the Saguenay or Hamilton Inlet. Fault planes have helped to produce the valley of the St. Lawrence, and probably the lower Ottawa valley as well. The effect of the fold valleys upon the evolution of the rivers in British Columbia has been remarkable. The ' bypass bifurcation ' of the Kootenay is worthy to rank with the classic Cassiquiare, and is described later. The melting of the icebound upper waters of the Mackenzie basin in the spring, long before the northern ice thaws, produces remarkable seasonal floods in that part of the Dominion. Many other peculiarities of the hydrography will appear in later pages.

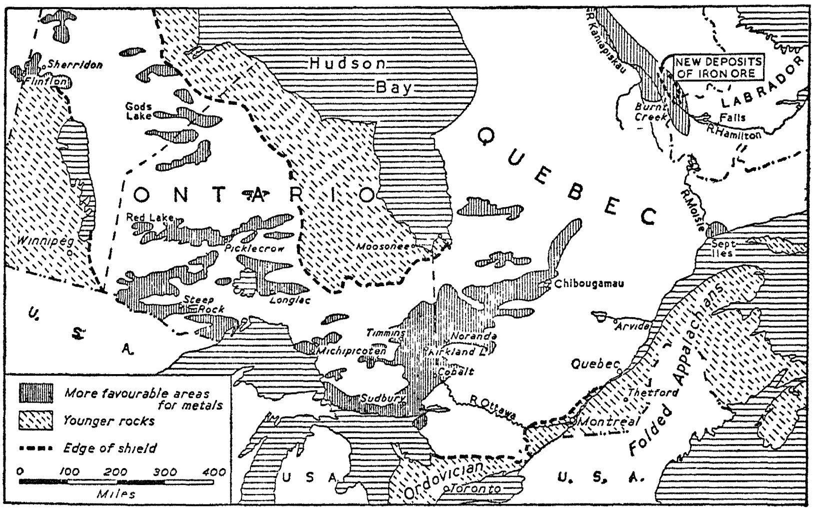


FIG. 16A.—The Canadian Shield, South-East portion, showing most favourable areas for metals. (Based on Dept. of Mines, Ottawa.)

CHAPTER IV

CLIMATES OF CANADA [1]

A GOOD introduction to the subject of this chapter is to consider the question 'Has Canada a normal Climate?' Everyone knows that the climate of most of Canada differs greatly from that of the British Isles, though large parts of Canada are in much the same latitude. London, England, is 600 miles farther from the Equator than London, Ontario, yet the latter has a very cold winter with a temperature in January of 25° F., while the English city is about 38° F. Which is normal? The best criterion is the average temperature for the latitude concerned. Thus, along latitude 42° N., which runs near Chicago and Toronto, the average temperature in

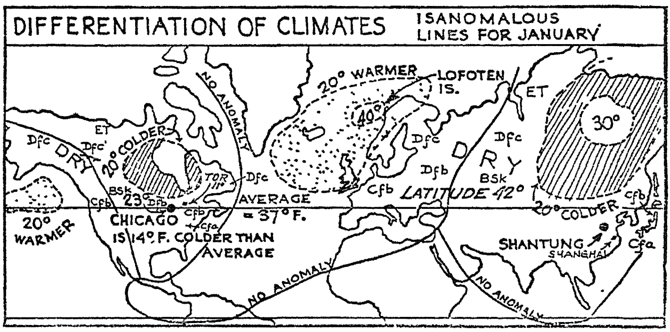


FIG. 17.—A chart showing Isanomalous lines for January, and suggesting foreign climates akin to those of Canada. The *ruled* areas have mid-winters much colder than the averages for their latitude. The *dotted* areas have mid-winters much warmer. Köppen's formulae for Canadian climates are also added

January is 37° F., but at Toronto the temperature is 11° F. colder. If we turn to Europe we find that Barcelona (which is on the same latitude) is 9 degrees warmer than 37° F. These two departures from the average figure (− 11° and + 9°) are called January *Anomalies*.

If we plot these January Anomalies by means of isopleths, as in Fig. 17, we obtain a series of Isanomalous lines which are very instructive. The lines for 20 degrees colder than normal (for the

[1] Monthly temperatures and rainfall for nineteen stations appear at the end of this chapter.

respective latitudes) and for 20 degrees warmer are shown on the map. Now we are ready to answer our question. All places near Hudson Bay are much colder than the average for the latitude. The same is true for all eastern Siberia. These two large colder patches are indicated by the diagonal ruling in Fig. 17. In the same way we find that Britain, Norway, and Iceland are much warmer than one would expect in January, considering their latitudes. There is nothing in North America to compare with this extra warm area, though British Columbia comes nearest to it.

We find that southern Canada resembles southern Siberia and north China much more than it does Britain. Such similar regions are called Homoclimes; and Canadian geographers must always be vitally interested in the experiments in settlement being carried on in Siberia for this very reason. It will be noticed that the line of 'No Anomaly' for January runs through Newfoundland, which has just about the average temperature of its latitude. It may be stated to have the *normal* climate; while most of Canada is much too cold, and Britain is much too warm to be called 'normal'. One could of course find the anomalies for other months than January; but it is the midwinter month which to a large extent determines the type of climate in temperate lands. For instance, if we were to compare the three places mentioned in regard to July temperatures we should find the anomalies (Toronto 0°, Newfoundland − 8°, Barcelona 5°), considerably less. Put in another way, the large annual range of temperature, which is so marked a feature of continental climates like Canada, depends much more on very cold winters than on very hot summers. Thus the west coast of Hudson Bay has a January anomaly of − 30° F. but a July anomaly of only − 2° F. (Batchelder).

Thus the very cold winters are a marked feature of much of Canada. A second marked feature is due to the high latitudes of much of the Dominion, and this aspect of climatology may well engage our attention for a short time. At the North Pole the sun shines (theoretically) for 24 hours a day for six months of the year. By the time we have moved south to latitude 43½° N. (at Toronto) there is no such long period of daylight in the summer. Actually on 21st June the sun is visible for only about 15½ hours, which is of course a shorter day than is experienced in the British summer. Around Christmas Toronto has about 9 hours of daylight.

In Fig. 18 is given a graph of the length of the day at various latitudes in the Dominion. It is of great importance in agriculture, since it shows what a long growing period for plants is to be found in northern Canada. The twelve months are named across the graph at the foot, while the varying latitudes appear at the right-hand side. If we glance along the horizontal line labelled 'Toronto', we see

that in December the days last 9 hours, in March about 12 hours, and as we have seen in June about 15 hours. Now turn to latitude 66° N., as shown by the Great Bear Lake in the graph. Here on December 21st we have no daylight, in March there are 12 hours of daylight, and on the 21st of June 24 hours. This lake is of course on the Arctic Circle.

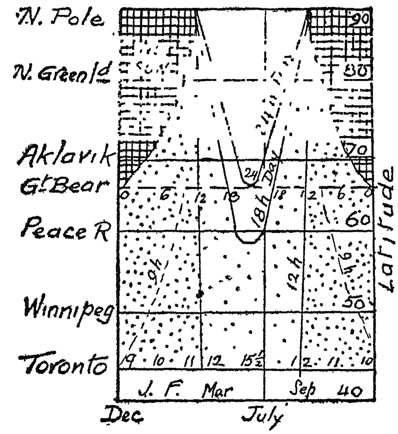


FIG. 18.—Length of day during the year at various latitudes

Now consider what this means at such pioneer regions as Peace River in northern Alberta, and along the Mackenzie River down to Aklavik near its mouth. Most of our important plants such as wheat, oats, potatoes, &c., make nearly all their growth in the four warm months of May, June, July, and August. It is clear from the graph that this northern region receives sunshine not for 12 hours but from 17 to 24 hours in the day during most of the growing period. This great length of day in the summer compensates a good deal for the bitter conditions of winter.[1] Luckily, as many plants are out of the ground in winter, it makes little difference to them how bitter the winter may be.

We can give more exact figures for the amount of heat received in the 24 hours in the various latitudes in summer, as in the following table from Koeppe[2]; here the units used are rather complex (gram-calories per square centimetre), but we are concerned only with their relative values at the various latitudes.

[1] Newton has shown recently that the duration of *warm* conditions is far more important than the long hours of daylight to grain crops in northern Canada.

[2] *The Canadian Climate*, by C. E. Koeppe, Bloomington, Illinois, 1931. A useful descriptive work with numerous maps and tables.

HEAT RECEIVED IN 24 HOURS ON JUNE 21ST AT VARIOUS LATITUDES

Latitude:	40°	50°	60°	70°	80°	90° (Pole)
Heat units	490	510	480	470	450	340

Thus on Midsummer Day there is no vital change in the heat received in the 24 hours, whether the crop is at Toronto (latitude 43°) or at Aklavik, north of the Arctic Circle (66°). Of course these special conditions hold only near midsummer, as a glance at Fig. 18 will show.

Temperature Conditions in Canada

The average annual isotherms for Canada are charted in Fig. 19. They have kindly been prepared by Mr. A. J. Connor of the Dominion Meteorological Service, whose manual of the Climate of Canada in

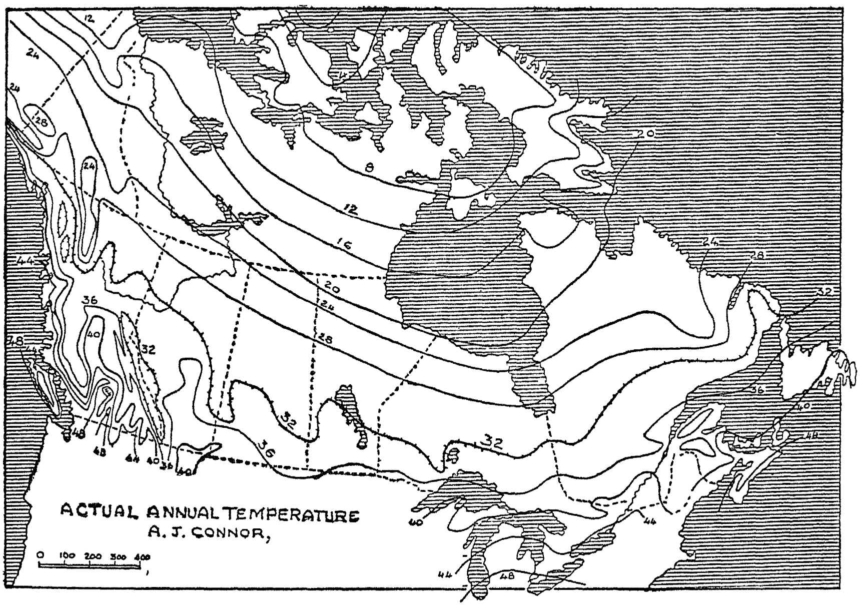


FIG. 19.—Actual Annual Temperatures—not reduced to sea level. Note the warmth of southern Alaska equals that of Nova Scotia. (After A. J. Connor)

the Koeppen-Geiger *Handbuch der Klimatologie* (Berlin) should be consulted by all readers who wish to proceed farther with the study. Owing to the great topographic variation in the Dominion, the data for the relatively level east and centre are much more reliable than

those for the very rugged western portion. Indeed in British Columbia and Yukon the climatic elements necessarily tend to follow the contours, especially in the case of temperature and rainfall. Since the few meteorological stations in the north of British Columbia and in the Yukon are almost wholly in the valleys, where the sole settlement is to be found, the various isopleths are only first approximations to the truth.

The first feature to be noticed in the map of the annual temperatures is that nearly all of Canada but the southern margin has average temperatures below freezing-point. The isotherm for 32° F. runs from the north of Newfoundland to the north of Lake Superior, and thence to the west and north-west through northern British Columbia. It is a misfortune of Canada that the region which receives most warmth from the Pacific Ocean is precisely the most rugged, and therefore least able to benefit from this much to be desired warmth.

The second feature is that the isotherms do not run west-east parallel to the lines of latitude, but have a very definite slant to the north-west up the Mackenzie Valley. Thus the isotherm for 24° F. is in latitude 55° N. in the east, but runs north to 65° N. in the far north-west of the Dominion. The relatively warm character of the Mackenzie Valley, especially noticeable in summer, is an advantageous element in the settlement of northern Canada.

Rivalling the south-west corner of British Columbia, and with a much more satisfactory topography, is the extreme south of Ontario. This peninsula, between the three great lakes of Huron Erie and Ontario, has average temperatures over 40° F. Down in the extreme south, on the shore of Lake Erie, we shall find that a good deal of land is devoted to the growth of vines and tobacco; crops which are not usually associated with the cold Dominion.

The 'cold loops' due to the high elevation of the Rockies have been inserted as well as the data permit. They are quite marked in the case of the lines marked 24° F. in the north of British Columbia, and in the case of isotherms 32° F. and 36° F. in the south of that province.

The temperatures in January are shown in Fig. 20. The isotherms offer a number of interesting variations depending chiefly on the presence of the mountains and the warm seas. The continent is very cold in this month, as is obvious from the isotherm of — 29° F. which lies over the Boothia Peninsula and the littoral to the south. It is to be noted that in winter the Arctic Ocean near the Peninsula has no effect in warming the atmosphere, for the isotherms run at right-angles to the coast hereabouts. Very different is the state of affairs along the Pacific coast where the temperature of freezing-point (32° F.) runs almost along the coast of British Columbia.

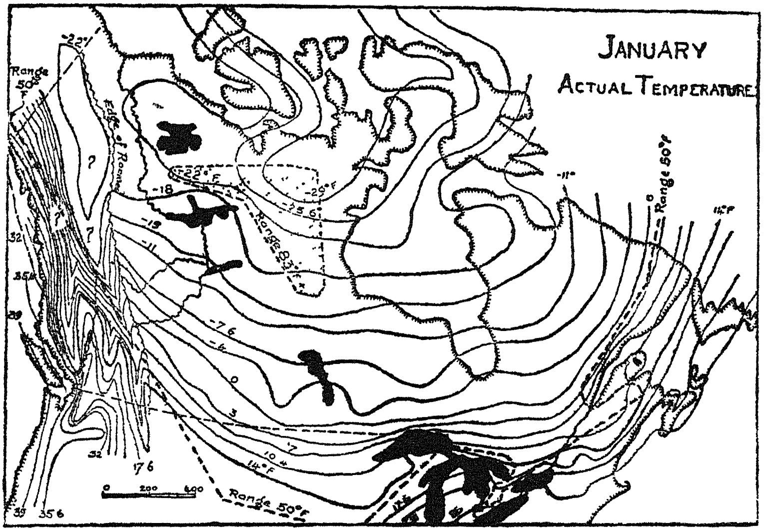


FIG. 20.—Actual Temperatures in January. Only the vicinity of Vancouver has temperatures above freezing-point. The Annual Ranges of Temperature for 83° F. and 50° F. are given in heavy broken lines

On the shores of the Atlantic Ocean the isotherms are nearly parallel to the coast in the Maritimes, but are not so much affected by the ocean waters as we move north into Labrador. There is of course a cold current along this coast which reduces the ameliorating effect of the ocean, in much the same way as does the pack ice of the Arctic.

It will be noticed that the sole extensive lowland region in the Dominion with a temperature above freezing-point in January is the Frazer Delta near Vancouver. Vancouver Island and the actual coast of the mainland nearby, which is mountainous, also have similar temperatures. The farmlands of southern Ontario are, however, so far south of the rest of the Dominion that they are considerably benefited, all having temperatures above 14° F. Near Windsor the average is about 26° F.; and these temperatures are reached in January by the sea-washed promontories of Cape Sable (N.S.), Cape Breton, and Cape Race (Newfoundland).

A second feature of the isotherms is the way they are 'packed' on the south-east, south, and especially on the west, whereas in the north of the Dominion the temperature gradient is less steep. For instance, the average gradient for latitude is about 1 degree Fahrenheit per 1 degree of latitude. In January this gradient is found only in the vicinity of Hudson Bay. Elsewhere the gradient is far steeper; for instance, between the Pacific and Great Bear Lake the tem-

perature falls from 28° F. to − 22° F., a total of 50 degrees Fahrenheit in a distance of 9 degrees of latitude. Thus here the isotherms are packed about five times as closely as usual.

The isotherms for the month of July are shown in Fig. 21. Now the northern coast is paralleled by the isotherm for 43° F., i.e. the Arctic Ocean is exerting the normal oceanic effect. The cooling due to the Rockies is clearly shown by the ‘ Cold Loops ’, especially in the isotherm for 14° C. (57° F.). Very remarkable is the change

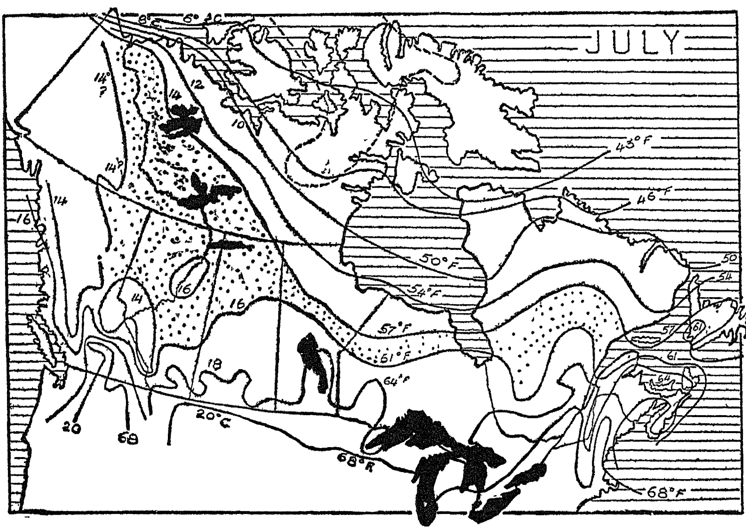


FIG. 21.—Isotherms for July in Canada. It is primarily the *summer* temperature which determines the limits of crops. The wide dotted triangle is where the future expansion of crops may take place. Centigrade in west

in the gradient on the traverse from the Pacific to Great Bear Lake. In July there is practically no difference between the temperature on the coast and in the far interior, since both are about 57° F. In January, as we have seen, the temperature fell 50 degrees on this traverse. Thus the gradient in the interior is very much less in summer than in winter. In the Maritimes there is a tendency for the isotherms to form ‘ warm loops ’ around the promontories as shown by the isotherm for 61° F. and 57° F. (in Newfoundland).

However, the most striking feature in the summer, and one of profound importance in regard to the settlement of Canada’s pioneer lands, is the course of the 57° F. isotherm. It takes the form of one of the most remarkable ‘ warm loops ’ in the world. The whole of the Mackenzie basin is much warmer than other Canadian lands in the same latitude ; and this unusually warm area is emphasized by

dots in Fig. 21. No doubt this isotherm is only approximately charted, but we may be sure that the temperature at the mouth of the Mackenzie in latitude 70° N. is about as warm in July as Anticosti Island in latitude 50° in the Gulf of St. Lawrence. It is interesting to note that though Halifax is warmer than Vancouver in summer (65° F. and 63° F.), as we should expect from the latitude, yet in winter Vancouver is 35·5°, while Halifax is only 23° F.

Since North America is the second widest land in northern latitudes, it is natural that it should exhibit ranges of temperature second only to those of Asia. Range of temperature (between the averages for July and January) depends essentially on two factors. These are distance from the equator—which means less solar heat—and distance from the ocean—which means greater heat in summer, and greater coolness in winter. Both these factors are quite important in the interior of the wide domain of Canada; and we find one of the world maxima in this connexion just to the east of Great Slave Lake in the vicinity of Dubawnt Lake. Here a range of about 84° F. is reached, and it is shown in position in Fig. 20. Very little of the Dominion has a range less than 50 degrees, which would be called a high figure in Europe. The isopleth for 50° F. is shown on Fig. 20. All to the north of this line can fairly be claimed to have a *Continental* Climate. The two corners of Canada which lie outside this isopleth approximate to a *Marine* Climate. They are seen to be in the vicinity of Vancouver in the west; and the Maritimes and Newfoundland in the east. It is clear then that very little of the Dominion has any resemblance to the cool, moist, equable or *marine* climate of the British Isles.

One of the chief features of the climate as regards the growth of crops is the length of the frost-free period. A somewhat tentative map compiled from a number of sources (including the valuable *Agricultural Atlas of the Prairies*, Ottawa, 1931) appears as Fig. 21A. Wheat, barley, and potatoes are differently affected by frost; so that we can say that wheat needs about 100 days free from frost, barley about 80, while potatoes will grow with still shorter periods of warm weather. Ludwig Mecking, the eminent German geographer and climatologist—who has studied polar conditions very widely—suggests the limits shown on Fig. 21A for crops near James Bay. Of course soils are important, but are not considered in this diagram.

Average Pressure Conditions

Canada is situated in Cool Temperate and Sub-Polar latitudes, so that its pressure conditions are due to its position in the northern belt of Low Pressure. In January and July the following are the pressure averages at the various latitudes in the northern hemisphere (Hann).

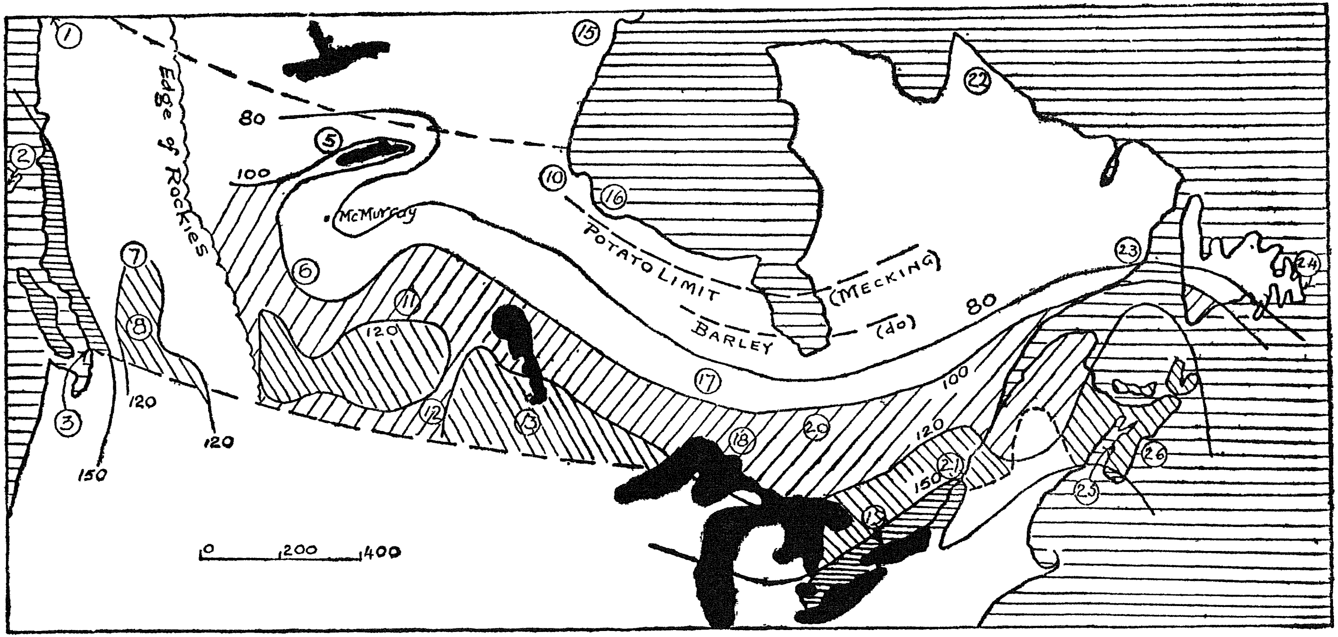


FIG. 21A.—Map showing days free from frost. (Numbers in circles refer to the table of winds given later)

WORLD LATITUDE AND PRESSURE

Latitude:	40°	50°	60°	70°	80°
January (inches)	30·05	30·0	29·93	29·92	29·80
July (inches)	29·90	29·88	29·83	29·85	29·87

The lowest pressures on the average occur along latitude 65° N., but this is not the case in Canada, where the continental effect is dominant. In the winter there is a very marked centre of Low Pressure in the vicinity of Iceland which is known as the Semi-Permanent Low, and a somewhat similar centre near the Aleutians in the northern Pacific Ocean, which reduce the pressures in these latitudes, as shown in the table.

The distribution of pressures is somewhat complicated by the monsoon effect of the large land mass of North America. A glance

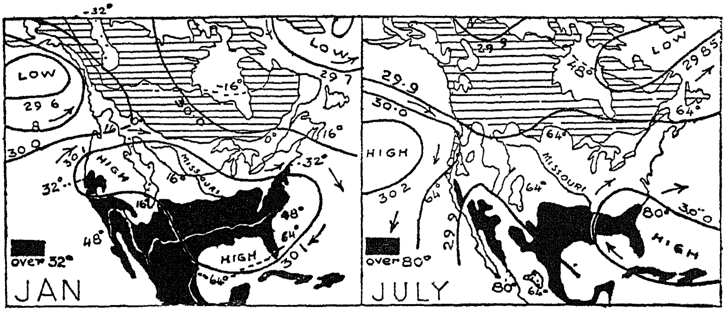


FIG. 22.—Isobars for January and July for North America

at the two maps given in Fig. 22 will show that the chief feature of the two seasons charted is the marked High Pressure which covers the United States in January. This gives to Canada a general pressure gradient from south to north; i.e. from 30·1 along the southern border to 29·7 on the north-east and north-west. In summer the gradients are not so pronounced; and indeed all Canada has an average barometric level of about 29·90.

However, these average figures are of less value in southern Canada than in any other region in these latitudes, for the characteristic feature is the ever-varying changes of the barometer due to the great number of cyclones, or low-pressure eddies, which cross the Dominion. The average annual frequency of these storms (or low pressure eddies) in North America is shown in Fig. 23, which is based on data collated by H. C. Dunwoody. The black oval in Ontario shows the region where 45 storms occur in the year. The

isopleths form ovals concentric about this area, with the area least affected by such storms around the former Magnetic Pole in Boothia Land. This is also the coldest part of Canada, and the region with least precipitation, which suggests quite correctly that storms are usually accompanied by (and due to) high temperatures and considerable moisture.

The cyclonic storms are of course eddies in the lower atmosphere which move from west to east in accord with the general direction of the air circulation in these latitudes. The average path is shown by the large arrow in Fig. 23. From the frequency of these rain-

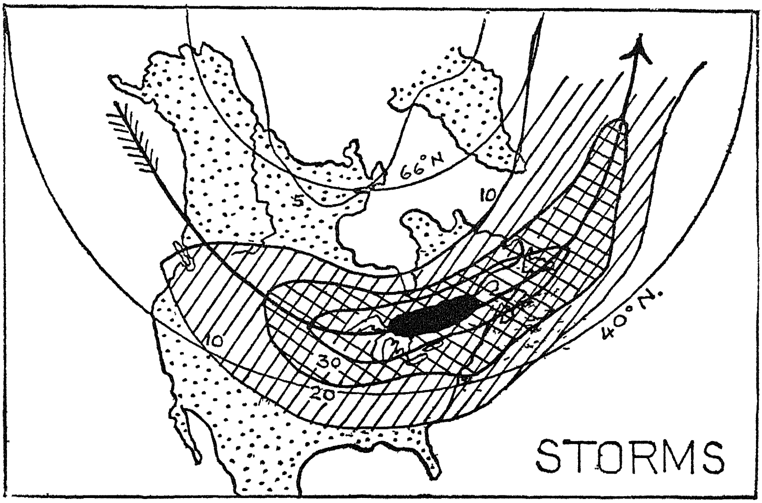


FIG. 23.—Annual frequency of storms. The black area has 45 storms per annum. The arrow shows the most frequent path of the storms. (After Dunwoody)

bearing storms it follows that the Great Lakes Region is one of considerable uniformity in the character of the rain; and, indeed, Toronto has one of the most uniform rain regimes in the world with about 2·7 inches in each of the twelve months (Fig. 29).

There has been a considerable change in technique in the outlook upon the daily weather maps and upon the origin of temperate rainfall in the last twenty years. Due to the research of Bjerknes and others, the emphasis is now laid upon *Air Masses* rather than upon areas of *Low Pressure* (Cyclones), as was formerly the case. Even in this brief summary of the Climatology of Canada some account of the Air Mass concept is advisable.

When students of the atmosphere began to obtain fairly extensive data as to the conditions of the atmosphere some little distance *above* the surface, they found that air which had remained for

some considerable time over a warm sea or a cold land took on fairly stable characteristics of temperature and moisture. If later this large air mass drifted away (usually to the east) it did not lose these characteristics for a relatively long period. If it came in contact with an air mass of a different character, then mixing took place very slowly. Along the plane of discontinuity, where the two masses were in contact, many striking features developed. Indeed, it may be stated that the ' intense cyclone with close-set isobars ' (which was the chief ' hallmark ' of an old-time weather map) was itself the result of this ' collision ' of two such masses. Today meteorologists therefore study the whole ' plane of discontinuity ' instead of merely one major ' eddy ' (the cyclone) which developed thereabouts. Favourite positions for cyclones to develop are suggested by the word LOW placed on the planes of discontinuity in Fig. 24.

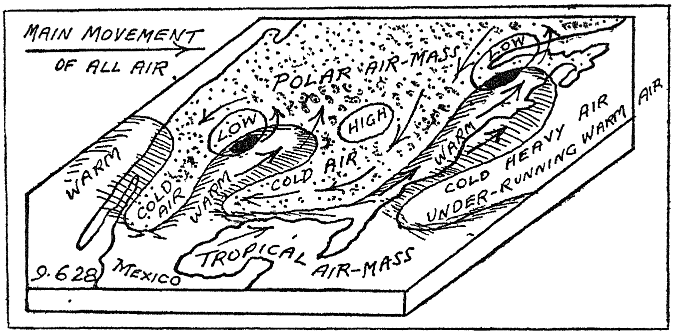


FIG. 24.—A sketch to show the relation between the Polar Air Mass (dotted), and the regions of heavy rain (black), and the Lows

In Fig. 24 the conditions which operated over North America on the 9th of June 1928 are represented in a somewhat generalized fashion. We see the cold heavy Polar Air Mass over the north of the continent sending out two tongues. These consist in general of cold dry air which is rather dense, and so under-rides the lighter air from the tropics. In the south-east is another air mass which has been long enough over the vicinity of the Gulf of Mexico to acquire much heat and moisture. Compared to the northern air mass it is relatively light; and it is therefore lifted by the cold wedge-shaped front of the polar air mass.

It must be realized that this fluctuating margin of polar air with its numerous tongues is rotating as a whole about the North Pole from west to east. Hence the polar ' tongues ' and tropical ' tongues ' are also carried to the east. The whole mechanism reminds one of a circus ' merry-go-round ', where the horses bob up

and down, while the whole apparatus rotates round the central pole of the tent.

The deposition of rain naturally takes place on the margins of the warm moist tropical tongue. In general the western side of this tongue is where the polar air as a whole is moving forward to the east; and this is known as the *Polar Front* (C). The eastern side of the warm tongue is where the warm air as a whole is moving to the east, and this is accordingly the *Warm Front* (W).

There are several other types of air mass which may drift over the continent; for instance Polar Pacific and Tropical Pacific air masses. The former is naturally moister than Polar Continental air (as shown in Fig. 24). Tropical Pacific air is rarely of importance in Canadian regions.

Winds of Canada, the Chinook

Since the settled part of Canada—extending along the southern border of the Dominion—is precisely in the path of the wandering cyclones shown on Fig. 23 it is clear that the *variable weather* is perhaps the outstanding feature of the climate of this part of North America. In the front of the cyclone the winds are from the south; in the rear from the north. However, in the more northern parts of the Dominion there are certain seasonal winds which deserve a brief discussion. The numbers given in the table will be found on Fig. 21A.

If we analyse the results given in this table, we find that there is not much change in the winds round the coasts of Canada, but that there is a considerable wind-shift from January to July in the belt extending across Canada from Dawson to James Bay. In this belt there is a strong tendency for the south-westerly winds of winter to change to north-easterly winds in the summer. This corresponds of course to the shift from high to low pressure of the barometer in the west of the United States (Fig. 22).

There is one very striking type of wind for which the Canadian Prairies are famous, and that is the 'Chinook'. This is the local form of the well-known *Foehn* wind of the Alps. It is a hot dry wind which blows usually down the slopes of a mountain scarp or mountain valley and may raise the temperature of a place by 30 degrees or so. In Europe it occurs near Lake Constance and on the northern slopes of the Alps, and the hot air was at one time supposed to come from the Sahara.

The term Chinook seems to have been first applied to winds in the vicinity of Astoria (Oregon), and only in later days was it applied to the hot winds on the east side of the Rockies. In Alberta it is a westerly wind which introduces a warmer air mass which is comparatively dry. H. L. Osmond (in *Canadian Jnl. of Research*, 1941)

DOMINANT WINDS IN CANADA

(Sub-dominant in brackets)

No.	Place	January	July
1	Atlin (B.C.)	South (N.)	North (S.)
2	Massett (B.C.)	SE. (SW.)	NW. (N.)
3	Vancouver	East (SE.)	East (SE.)
4	Good Hope*	East (W.)	West (E.)
5	Chipewyan	North (E.)	East (NW.)
6	Edmonton	NW. (SW.)	NW. (NE.)
7	Prince George	South (SW.)	SW. (S.)
8	Kamloops	West (E.)	West (E.)
9	Dawson (Yuk.)	South (N.)	North (S.)
10	Churchill	NW. (W.)	NE. (NW.)
11	Prince Albert	West (NW.)	West (NW.)
12	Quappelle	NW. (W.)	NW. (W.)
13	Winnipeg	NW. (SE.)	SE. (NW.)
14	Jones Sd.†	North	North (S.)
15	Chesterfield	NW.	NW.
16	Port Nelson	West (SW.)	NE. (NW.)
17	Fort Hope	West (NW.)	West (N.)
18	White River	NW. (S.)	SW. (W.)
19	Toronto	West (SW.)	SW. (NE.)
20	Abitibi	West (N.)	West (N.)
21	Montreal	West (SW.)	West (SW.)
22	Hebron	West	West (N.)
23	Harrington	NW. (N.)	SW. (W.)
24	St. Johns	NW. (SW.)	SW. (NE.)
25	Annapolis	West (N.)	West (NW.)
26	Halifax	NW. (SW.)	SW. (S.)

* Where the Mackenzie crosses the Arctic Circle.
† South of Ellesmere Island, Lat. 76°.

has given a recent discussion of the chief characteristics of these interesting winds. There is always a marked low-pressure area to the east of the Rockies, usually centred in the district between Great Bear Lake and James Bay. Osmond finds that the features are more pronounced if there be two centres of high pressure, centred (as shown in Fig. 25) in southern British Columbia and southern Alberta.

Before the Chinook is evident at Lethbridge and Calgary, there is a line of temperature discontinuity along the leeward (east) side of the mountains. The Chinook is generally stronger and steadier at Lethbridge than at Calgary, though the change of temperature is usually greater at the latter place. This wind may arise at any time of the day, but the drying effects usually do not extend farther east than Swift Current and Saskatoon. The westerly winds are often

strong and persistent; as for instance at Lethbridge in March 1939, when the wind continued for five days with an average velocity of 26 miles per hour. Ward describes a Chinook wind in Montana (in December 1896) in which the temperature rose 34° F. in seven minutes, but this is exceptional. This characteristic feature is of course due to the adiabatic heating which the air experiences as it descends and is compressed in the lee. Since it has often lost much moisture on the west of the mountains it is always dry. The cold-weather Chinook is of considerable importance to the settler in southern Alberta since this is an important ranche area. The hot winds 'lick up' the snow cover in a few hours, and so enable the cattle to graze on the grass which has been hidden by the deep snow.

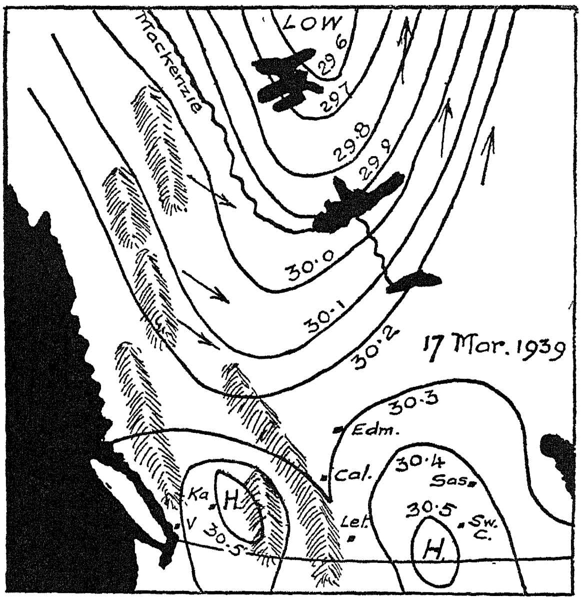


FIG. 25.—A typical Weather Map at the onset of a Chinook period. Note the Low east of the Rockies, and the two Highs in the southern Rockies. (After H. L. Osmond)

Since the most characteristic feature of the climate along the southern margin of Canada is the passage of a constant 'procession' of cyclones or Lows, it is clear that frequent changes of weather are the rule. The general sequence is for the onset of a Low to be marked by southerly winds, cloudy skies, and usually hotter weather, with more or less rain. At the rear of a Low the wind changes to a northerly direction, and is cool and dry. Such changes occur throughout the year, but have naturally rather different effects in

winter from those in summer. For instance, in summer the hot moist wind accompanying the arrival of a Low is felt to be uncomfortable by most people. If the Low is 'stagnant', i.e. does not move to the east at its normal rate of about 500 miles a day, the 'muggy' weather persists, and we experience a 'heat wave'. Actually southern Canada is being bathed in a mass of air which has probably come up with little change from the Gulf of Mexico. On the other hand, in the winter the keen, cold, northerly winds at the rear of a Low are not attractive at this season; and if the Low halts in its progress to the east we experience a 'Cold Wave'. The air has been transferred bodily from the cold north-west of the interior of Canada; and if it is accompanied by considerable snowfall the condition called a Blizzard may develop.

The spell of pleasant weather which often occurs in October or November, after the leaves have fallen and the climate has definitely moved towards winter conditions, is known as the 'Indian Summer'. It may last for several days or a week, but it is essentially due to the same controls as just described. The Low has halted (west of the place concerned) on its path to the east, and a broad mass of warm moist air derived from the southern tropical region covers the portion of southern Canada under consideration. Earlier in the year this same feature would perhaps produce a heat wave, while in winter it gives us welcome warmer conditions, but is not termed 'Indian Summer'.

Rainfall in Canada

It is interesting to compare Australia and Canada as regards the major climatic elements. In the former continent it has been stated that 'the Government leases *rainfall* rather than land' in its efforts to settle the empty Australian spaces. This is because the great evil in Australia is sheer lack of water-supply. But very little of the cool Dominion receives an annual rainfall less than 10 inches, perhaps only about 10 per cent, while in hot Australia about one half can fairly be termed arid. It is of course the long period of cold which is the chief obstacle in the way of human occupation in Canada, so that temperature, on the whole, is a more important element than rainfall in the Dominion.

In Fig. 26 has been sketched the annual rainfall map, from data published by Connor, Brooks, and Mackintosh. In conjunction with the temperature map this chart is of the greatest importance as regards the future settlement of the Dominion. We notice at once that the regions of good rainfall are found only on the west and south-east coasts. These are of course adjacent to relatively *warm* oceans, which is not the case on the north-east and north coasts. Cold oceans are not of much use in producing rain.

The topography of Canada is not arranged as happily as that of Europe, for the numerous ranges of western Canada lie at right-angles to the steady drift of the air to the east. Hence much of the rain is precipitated on the coastal ranges, and relatively little arrives far inland. In Europe the main mountains have a west–east direction, so that the similar drift of the air to the east takes the moist marine conditions right into the heart of the continent to the great benefit of the latter.

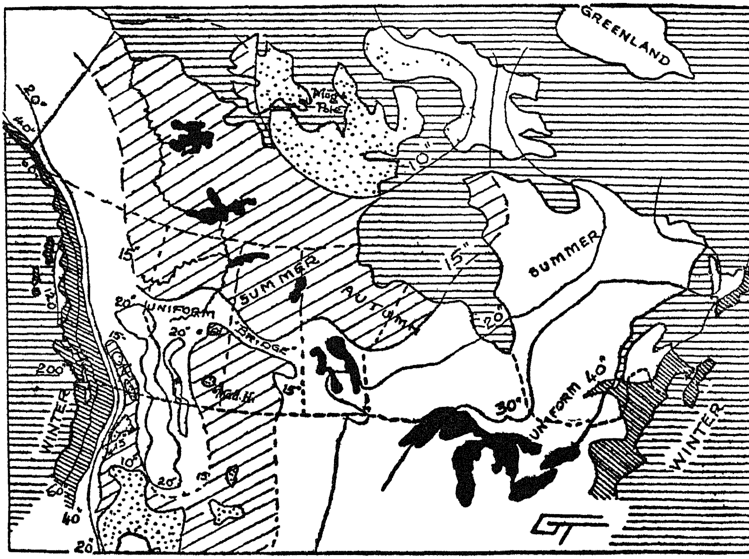


FIG. 26.—Annual Rainfall Map based on Connor, Brooks, and Mackintosh. The 15-inch isohyet is only approximate. The seasons of maximum rain are indicated. (See also Fig. 89)

Of the two wet coasts the western has much the heavier rainfall. Henderson Lake on the west (windward) coast of Vancouver Island had an average of 262 inches for the five years 1923–7. This is probably the heaviest rainfall in North America, and is of course due to the up-surge of the moist Pacific air over the mountain axis of the island. The whole Pacific coast has about 80 inches of rain, whereas on the coast of Nova Scotia it does not anywhere reach 60 inches so far as I am aware. On this latter coast the general drift of the air is from the land to the sea, though onshore winds are not uncommon, and they bring considerable rain to the margins of the Atlantic.

There are two large dry regions shown on the map by the dotted areas. One of these lies in the extreme north around the Magnetic Pole, though this is only a coincidence. The other is in the west

of the United States, where again the rainfall is below 10 inches a year. Between these two arid areas is a wide extent of territory with a rainfall between 10 and 15 inches, and this is shown by the diagonal ruling in the map (Fig. 26). This rainfall is too low for agriculture in really hot countries, such as northern Australia; but where the evaporation is small, as in cold countries, it is usually sufficient for some agriculture. Under these circumstances hardly any part of Canada has too low a rainfall for some crops, except in or near the Tundra (Barren Grounds) of the north, and near Medicine Hat and Kamloops. These dry spots are shown as dotted patches in Fig. 26. Perhaps the lowest rainfall in Canada is around Clinton in the Fraser basin, where the total is less than 7 inches a year.

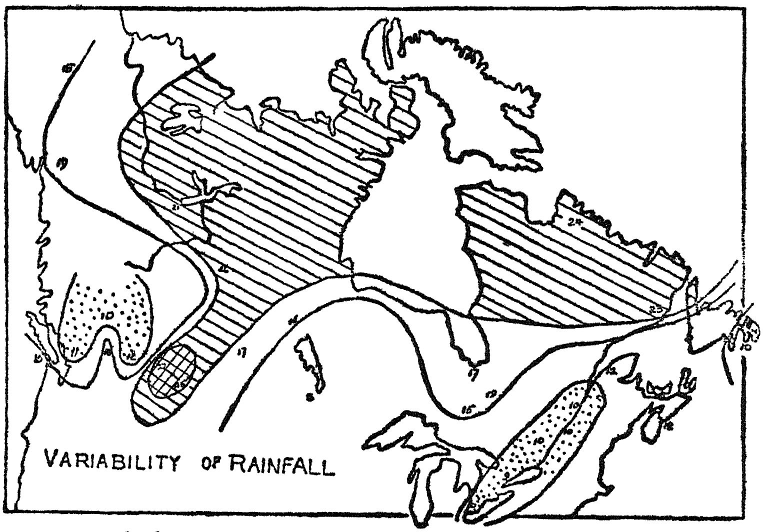


FIG. 27.—A chart of the Variability of the Rain (in percentage variations from the mean). The map is approximate, being based on only 30 stations

Of course season of rain and reliability of rain affect the above statements somewhat, and these areas of low rainfall are usually the areas where the rainfall is rather erratic. Thus one year the farmer may receive the average amount of 12 inches, but next year he may get only 5 inches, and another year 15 inches. This unreliable rain in dry areas makes farming very difficult. Biel in his map of Rain Reliability for the World charts this region in the interior of Canada (with a rainfall between 10 and 15 inches) as having a variability of 20–25 per cent departure from the normal. This is about the same as that of the much warmer wheat belt in eastern Australia, so that it should not prevent some agriculture.

A first approximation to a rain reliability map is given as Fig. 27.

To prepare this the rainfall history of thirty representative stations spread across Canada has been investigated. In most cases the annual rainfalls for twenty years since 1900 have been considered. In each case the departures from the mean, ignoring the sign, have been averaged. The average variability is then expressed as a percentage of the average total rainfall of the place. Toronto seems to have the least variability (i.e. greatest reliability) of the places under discussion. The average rainfall here is 800 millimetres, and the average departure, in the course of twenty years 1911 to 1930, is 72 mm. This figure is about 9 per cent of the average 800 mm.; and this figure '9' is the one charted in Fig. 27. For Calgary the average deviation is 111 mm. in an average total of 423 mm., i.e. 27 per cent variability. Isopleths drawn through percentage figures of this type give us the variability chart of Fig. 27.

The Arctic Coasts are those with the greatest variability; but since there is little likelihood of important agriculture or grazing in these regions this is not a matter of great concern. Unfortunately a considerable portion of the Prairies and of the land to the north-east is also rather unreliable, with a variability amounting to more than 20 per cent. Indeed the southern portion of the province of Alberta seems to be the worst in the Dominion in this respect. Reference to the annual rainfall map will show that this is also the driest part of inland Canada. Here, as in Australia, we find that the Biblical rule 'From them that have not shall be taken away' seems to obtain. However, it must be remembered that the isopleths have been drawn from rather few data, so that it is not worth while to discuss the reasons for the distribution in too great detail. The favourite path of the storms down the St. Lawrence is reflected in the great reliability of that part of the Dominion. So also the interior of British Columbia is reliable, although this region is unusually dry. This is somewhat unusual; for a reference to Biel's similar map for the world will show that the deserts are the regions of greatest variability. It is worth noting that nearly half of Australia has a variability exceeding 25 per cent while the Canadian map shows only a small area of this kind.

When the total precipitation is divided into that falling in the warm months (May to October) and in the cool months (November to April) some interesting features appear (Fig. 28). In the cool months there is a much greater concentration of the rainfall along the Pacific and Atlantic coasts, especially in the former locality. However, to balance this increase there is much less rain falling in the interior in winter than in summer, due to the absence of convection and thunder storms in the winter months. As usual with most of the lands of the world the chief season for rain is in the warmer months of the year. The presence of a sort of 'rain bridge'

connecting the wet east and wet west is well indicated in the summer chart, where a wet strip runs across the prairies from Winnipeg to Edmonton. This is not apparent in the cool months. The chief difference between the two seasons is that the 10-inch isohyet advances to the west from a position near James Bay in winter, to the Churchill River in summer. As we shall see, this zone of summer rain is an important area as regards future developments of cold climate crops (Fig. 28).

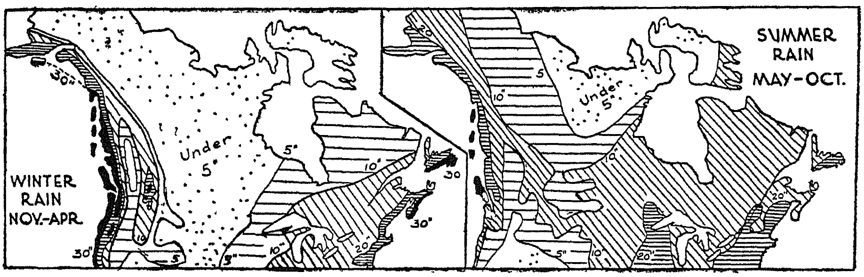


FIG. 28.—A comparison of winter and summer rains in Canada

According to Connor (*loc. cit.*) the Polar Pacific air mass tends to move to the south in the winter, and this seems to favour the greater rainfall in this season. Although the mountains produce a considerable amount of orographic rain, yet the valleys of the interior undoubtedly derive much of their summer rain from streams of warm air from the south. It may safely be stated that the climate of British Columbia is due to several different factors, including the position of the polar fronts as the various air masses pass over the province. Many more data are required before we can completely explain the rain regime.

On the prairies the chief feature of the rainfall is the gradual movement to the north of the maximum rain period. The warm moist air (to which the summer rain is due) gives rise to maximum rains in southern Texas, &c., in April; on the southern edge of Alberta this maximum occurs at the end of May; while along the lower Saskatchewan it arrives in July. From Lake Athabasca to the Yukon the maximum rains fall in August.

The main characteristic of the Seasonal Rainfall can best be understood by reference to the chart in Fig. 29. Here about 30 monthly rainfall graphs are placed on the map in their appropriate positions. They are all drawn to the same scale, with horizontal lines showing a monthly rainfall of 2 and 4 inches. The most marked seasonal variation is that shown for the district near Vancouver. The two graphs in this district both show very heavy *winter* rains, while only about 1 inch falls in July. Massett (on

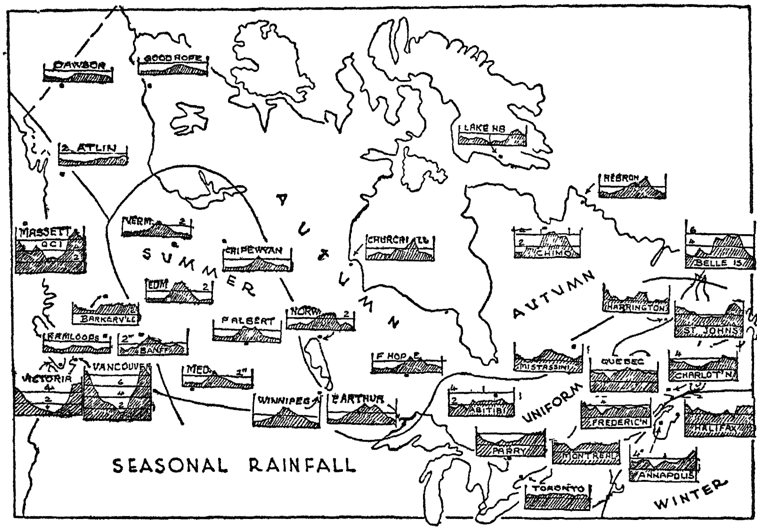


FIG. 29.—Monthly rainfall graphs for Canada placed in position on the map; showing winter rains on the coasts, and summer rains in the interior

Queen Charlotte Island) has a heavier rainfall, but here the midsummer is not so much drier than the rest of the year.

Inland behind the mountains the rainfall falls off greatly, as is shown by the graphs for Atlin, Barkerville, and Kamloops. Here the climate may be described as *arid*, and the amount of rain is low, but much the same in each month. The Prairies have a well-developed *summer* rain throughout the region between Fort Vermilion and Port Arthur; but the graphs show clearly that the more northern portions of the interior of North America are characterized by an *autumn* rain maximum. Indeed, in northern Quebec, &c. (Chimo, Hebron, Harrington), the hottest month in the year is August not July, and this type of delayed summer naturally tends to produce the heaviest rainfall somewhat later in the year than July. Thus in the graphs from Good Hope in the far north-west to Harrington in the east, the peak in the rain curve is found to lie in the autumn (Fig. 30).

In eastern Ontario, southern Quebec, and the Maritimes the rainfall is fairly *uniform*. As mentioned earlier, Toronto has one of the most uniform regimes in the world. This is related to the constant procession of Lows, which sail along the St. Lawrence every few days, and inevitably produce light to heavy rains in every month in the year. On the coast from Annapolis to St. John's (Newfoundland) there is a rather heavier fall towards the end of the year,

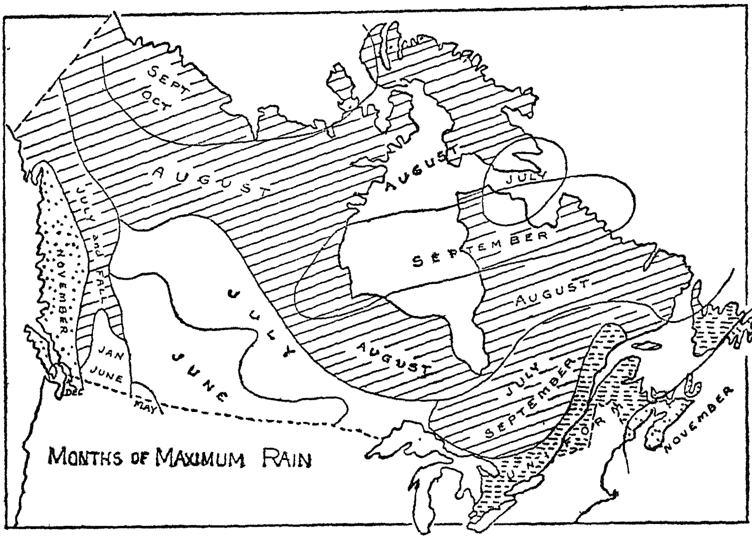


FIG. 30.—A chart showing the rainiest months in various regions. (Based on the *Canadian Year Book* for 1926)

giving somewhat of a winter maximum. In this region April seems to be distinctly a dry month.

Snowfall in Canada

The winter cover of snow is of great importance in many parts of the Dominion. Its measurement is always rather difficult, but the general procedure is to assume that 1 inch of rainfall is equivalent to 10 inches of snow. If the snow is packed closely its water content of course differs considerably from snow which is loose and fluffy, but in the long run the above equation is about right. Heavy snowfall depends of course on several favourable conditions. The temperature must be below 32° F.; but, as mentioned earlier, most cold regions are not favourable for heavy precipitation of any sort. Hence the heaviest snowfalls in the Dominion occur where the precipitation is heavy, though the temperatures here are by no means the lowest experienced in Canada.

The map shown in Fig. 31 has been compiled from various data, primarily from maps by Koeppe and Connor. But the stations are quite infrequent in the colder parts of the Dominion, so that this chart is only a first approximation. The heaviest snowfall is seen to occur in rather low latitudes near the Gulf of St. Lawrence, where it amounts to 120 inches or more on the high Laurentians behind Quebec. In northern Newfoundland the conditions are favourable for heavy snow, and about the same amount is registered there. The

rather high plateau of Labrador and eastern Quebec probably receives about 100 inches in the year, though there are no meteorological stations in the interior of this large region to give us accurate records.

As the relatively dry interior of the Dominion is reached the thickness of the snow cover diminishes, although as earlier maps have shown, the temperatures are much lower here in the winter than on the coasts. The settled part of the Prairies receives from 30 to 60 inches of snow, the isopleths agreeing fairly well with those of the rainfall figures. (In the latter maps the snow is of course included in the total rainfall recorded.)

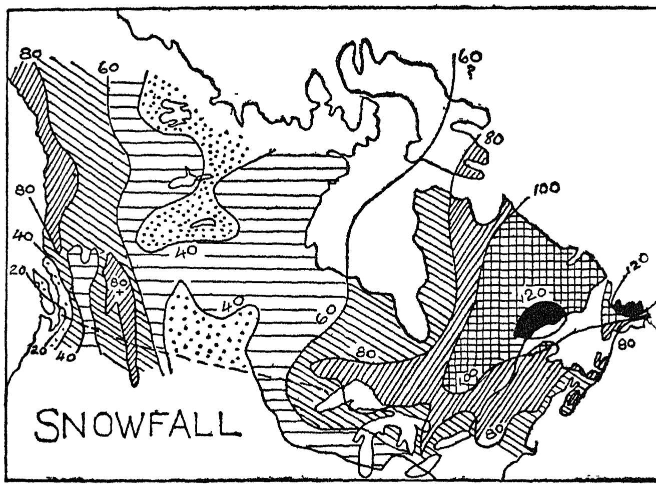


FIG. 31.—Snowfall in Canada, mainly based on A. J. Connor

In the mountain regions of the west, the usual complex isopleths are to be found, since the amount of snowfall is here much affected by the rapidly changing elevations. However, the mountains receive much of their precipitation in the form of snow, so that very high figures, amounting to about 400 inches, are likely for some of the elevated snowfields of the Rockies, Selkirks, and coastal ranges. These give rise to a great number of small glaciers, which will be discussed in the regional studies of this part of Canada.

The inland 'uplands' of British Columbia, with a general level of about 3,500 feet, are quite arid, and here the snow cover is usually below 40 inches. The amount rises again in the coastal ranges, and since the highest mountain in British Columbia (Mt. Waddington, 13,260 feet) is only 60 miles from the coast, we may be sure that there is a heavy deposit of snow on its windward slopes. However,

I am not aware of any accurate determination of the average annual amount on Mt. Waddington. On Vancouver Island the precipitation is very heavy, as we have seen, but the temperatures here are too high and the mountains too low for much of it to fall in the form of snow. Further to the north in Alaska there is a heavy snowfall, for here cold conditions and heavy precipitation often occur simultaneously. All along the northern coasts of the Pacific the snowfall is over 80 inches ; and on the higher slopes it doubtless rises to very high figures like those in the Selkirks.

Climatic Classes and Homoclimes

As mentioned in an earlier section there is hardly any land in the southern hemisphere in latitudes like those of Canada, so that the sole lands with climates at all similar to the subject of our study are found in the northern portions of the Old World. We can gain a fair idea of these similarities by reference to the well-known classes

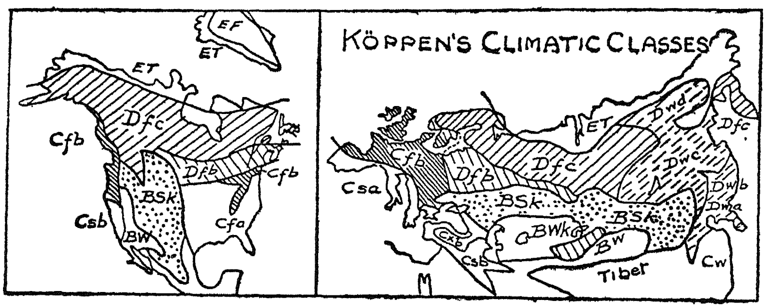


FIG. 32.—Köppen's Climatic Classes in Canada and Eurasia

worked out by Köppen for the whole world. They are shown for high latitude lands in a slightly generalized form in Fig. 32.

Nearly the whole of Canada belongs to Köppen's Dfc class, i.e. the *Microthermal Snow-forest* type with a fairly uniform rainfall, and less than four months over 50° F. In northern Europe and Siberia we see that there is an area almost as large of the same climatic type. In the east of Siberia, however, Köppen has separated an equal area in which the rainfall is (in his opinion) more definitely of the summer type. To this area he assigns the label Dw, but from the paragraphs on seasonal rainfall in this chapter, it should be clear that most of what Köppen calls Dfc in Canada might almost as well be labelled Dwc (or Dwb) ; for the rain is by no means uniform and has a definite maximum in summer or autumn. (Köppen emphasizes the *light* winter rain and so uses the formula Df.) However, in Fig. 32 I have made little distinction in the shading between Dfc, Dwb, and Dwc. Dwd is much the same except that the winters are extra severe. The

conditions for Dwb, with four months over 50° F., are fulfilled by much of the country between Calgary and Winnipeg.

The northern coasts are labelled ET in both continents, and this formula indicates the Tundra in Köppen's notation. There remain only two rather small areas in Canada, i.e. Cfb in British Columbia and Dfb on each side of the Great Lakes. The former is the 'Moderate marine forest climate' with a mild winter; and it is much more widespread in Europe than in western Canada. This is mainly due to the north–south direction of the mountains in Canada which shut off the interior from the benefits of the mild Pacific air.

As regards the Dfb climate this is 'the continental forest climate with a severe winter'. The areas are about the same in the Old World as in the New. In the former region it includes Poland and central Russia.

In the later regional descriptions this question of similar climates will be studied more closely by the use of the graphs called Hythergraphs. By using these twelve-sided graphs for a locality we can ascertain districts in the Old World which are almost identical as regards temperature and rainfall throughout the year with younger settlements in the New World. This technique is obviously of great value in regard to problems of acclimatization, and it offers us the best guidance as to the crops for which our Canadian pioneer lands may be suited.

The classes given by Köppen for Canada, and reproduced in Fig. 32, are rather too few for a detailed study of the Dominion. We may accept his classes as constituting the major divisions, but there is little resemblance between the climate of the Prairies and of the rugged country of British Columbia or of Alaska and the Yukon. We shall obtain great help in our classification when we consider the distribution of the natural vegetation, which we take up in the next chapter. As a tentative classification the divisions suggested in Fig. 33 are put forward.

It is obviously impossible to draw hard-and-fast lines between any two adjacent regions; but if we start with the premise that about a score of climatic divisions are advisable, then those given will probably be satisfactory to most students of the problem. The more definite boundaries are indicated by the heavier lines. For instance, every climatologist would separate the Tundra (Barren Ground) from the Coniferous Forest (Taiga) which lies to the south. There does not, however, seem much reason to subdivide this large area of Tundra, which is all labelled R in Fig. 33.

The small true Prairie region in the south-west has a somewhat different climate from that of the Taiga, being much more arid, as well as warmer. Another useful boundary, though not so clear perhaps as the preceding, is that marking off the Lake Forest Region

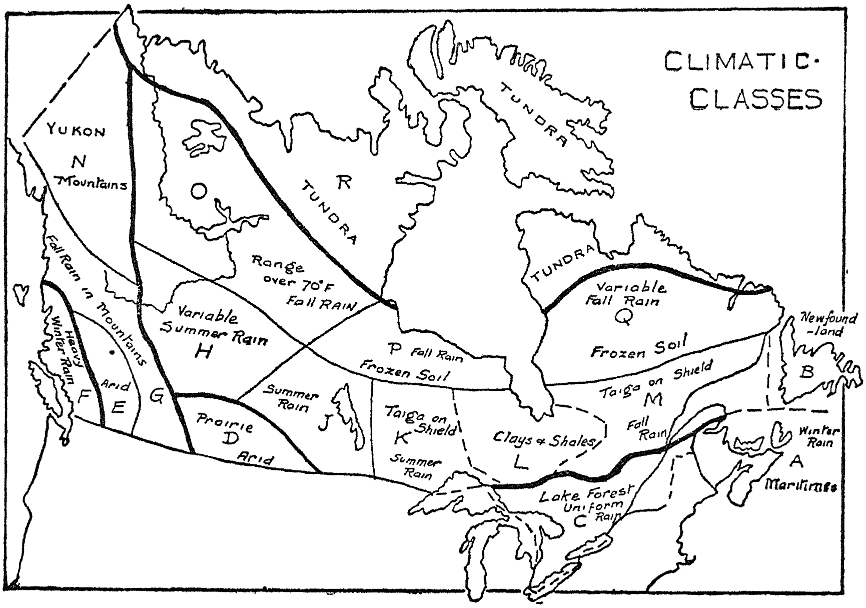


FIG. 33.—Canada divided into seventeen Climatic Regions. The major divisions are shown by heavier lines

in the south-east. In a different category are the two western main divisions, where topography has been used as a criterion. All the Rocky Mountain area is included by one heavy line, while another of equal climatic importance shuts off the extreme south-west coast with its heavy winter rains from the rest of the mountain climates of the Dominion.

Minor subdivisions are based on less important climatic criteria. As we have seen in an earlier map, the southern part of the Taiga usually has a *summer* rain, while the more northern belt has a *fall* rain. So also the *variability* of the rain increases towards the north, as does the *range* of temperature. Both of these are used as classifiers in appropriate areas. The southern limit of permanently *frozen soil* is related to the change in the character of the timber, and this is used near James Bay. In a few cases the geological or edaphic characteristics have been used as classifiers, as for instance with the large area just south of James Bay, where the Pre-Cambrian Shield is covered by Paleozoic sediments and Recent clays. Of course, when the Dominion is divided into 'Natural Regions', as in a later chapter, much the same divisions will be employed, though minor topographic features will be more frequently used in the smaller subdivisions. The Climatic Classes are summarized in the table herewith.

Climatic regions	Köppen	Temperature (° F.)		Rain total (inches)	Rain season*	Build, &c.
		Jan.	July			
A. Maritimes	Dfb	20	64	40	Winter, R	Paleozoic Basin
B. Newfoundland	Dfc	20	57	40	Uniform	Paleozoic Plateau
C. Lower Lakes	Dfb	14	68	35	Uniform, R	Paleozoic Basin
D. Prairie	BS	7	64	13	Summer, V	Cretaceous Basin
E. B.C. Uplands	BS	18	61	12	Uniform, R	Complex Folds
F. B.C. Coast	Cs	32	61	80	Winter, R	Complex Folds
G. S. Rockies	Dfc	0	55	20	Fall	Complex Folds
H. Athabasca R.	Dfc	0	59	16	Summer, V	Cretaceous Basin
J. Manitoba	Dfc	− 5	62	18	Summer	Paleozoic Cuestas
K. W. Ontario	Dfc	0	62	25	Summer	Pre-Cambrian Shield
L. Claybelts	Dfc	0	62	25	Fall	Clay over Shield
M. S. Quebec	Dfc	0	62	30	Fall	Pre-Cambrian Shield
N. Yukon	Dfc	− 20	50	12	Fall	Complex Folds
O. Mackenzie	Dfc	− 20	58	13	Fall, V	(Range over 70° F.)
P. Severn R.	Dfc	− 11	57	15	Fall	(Frozen Soil)
Q. Central Quebec	Dfc	− 11	57	25	Fall, V	(Frozen Soil)
R. Tundra	ET	− 25	46	10	Fall, V	Treeless Shield

* R, reliable rains ; V, very variable rains.

Note. Readers are referred to the large *Climatic Atlas of North America*, by Brooks and Connor (Harvard, 1936) ; and to the section in the Koeppen-Geiger Climatology (by A. J. Connor) for further details of the climate of Canada.

A new method of classifying climates—based on the comparison of precipitation with the water needs of crops, &c.—has been devised by C. W. Thornthwaite. Its application to Canada is described by Marie Sanderson in *Scientific Agriculture*, Toronto, November 1948.

All the lowlands in the Prairie Provinces, and north thereof, have annual *water deficiencies*, ranging from 2 inches all along the east to 10 inches in the extreme south of Alberta.

The new journal *Arctic* (published by the Arctic Institute, Montreal) gives a valuable article (and map) on the northern Weather Stations in the first number (spring 1948) by Andrew Thomson.

APPENDIX

CLIMATIC DATA FOR VARIOUS CANADIAN SETTLEMENTS

(Temperatures, °F.; Rain in inches)

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Year	
	T	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	T.	R.	Av. T.	Total R.
Charlottetown	17	3·6	15	3·1	26	3·2	36	2·9	48	2·7	58	2·7	65	3·0	65	3·3	58	3·4	47	4·3	36	3·8	25	3·8	41	43
Halifax	23	5·6	23	4·5	30	5·0	39	4·5	49	4·2	58	3·7	65	3·9	65	4·5	58	3·6	49	5·3	39	5·4	28	5·4	44	55
Fredericton	13	3·9	15	3·2	26	3·6	39	2·8	51	3·0	60	3·7	66	3·5	64	3·9	56	3·6	45	4·0	32	3·9	19	3·4	40	43
Quebec City	10	3·7	12	3·1	22	3·2	36	2·4	51	3·2	61	3·7	67	2·7	64	2·9	56	3·5	44	4·0	30	2·2	16	2·7	38	34
Montreal	13	3·8	14	3·2	26	3·5	41	2·5	55	3·0	65	3·5	70	3·7	67	3·5	59	3·5	47	3·3	33	3·5	20	3·7	42	41
Toronto	22	2·9	22	2·6	29	2·7	41	2·4	53	3·0	63	2·8	68	3·0	67	2·8	59	3·2	47	2·5	36	3·0	26	2·9	44	33
London (Ont.)	22	3·9	20	3·5	30	2·9	44	2·8	56	3·3	65	3·0	69	3·0	66	2·8	60	2·9	48	2·8	37	3·4	27	3·5	46	38
Cochrane (Clay Belt)	0	1·6	1	1·0	15	1·0	32	1·8	47	2·3	58	2·3	63	3·7	59	3·5	51	3·3	38	2·2	22	1·8	8	1·5	33	26
Winnipeg	−4	0·7	0	0·8	14	1·0	38	1·5	52	2·2	62	3·2	66	3·0	63	2·4	54	2·0	41	1·5	21	1·0	6	1·0	34	20
Churchill	−19	0·6	−17	1·0	−6	1·0	15	1·0	29	1·0	42	2·0	53	1·8	52	2·6	41	2·6	26	1·1	7	1·0	−10	1·0	18	17
Saskatoon	−3	0·5	0	0·4	14	0·6	38	0·4	50	1·6	58	2·5	63	2·5	60	2·2	50	1·5	39	0·7	22	0·5	9	0·6	33	14
Lethbridge	15	0·7	12	0·5	23	0·6	43	1·0	51	3·5	58	2·8	65	1·7	64	1·9	53	1·4	46	0·7	30	0·6	24	0·5	41	16
Edmonton	6	0·8	11	0·7	23	0·7	41	0·8	51	1·9	57	3·3	61	3·6	59	2·5	50	1·4	42	0·7	24	0·7	16	0·7	37	18
Vancouver	36	8·4	38	6·0	42	5·0	48	3·3	54	3·0	59	2·6	63	1·2	62	1·7	56	4·0	49	5·5	43	9·5	38	8·2	49	59
Prince Rupert (B.C.)	35	9·6	37	8·0	39	9·5	44	7·0	50	4·8	59	4·2	58	4·5	58	5·2	53	8·0	48	13·0	40	14·0	38	16·0	46	103
Kamloops (B.C.)	22	0·9	27	0·7	38	0·3	50	0·4	58	1·0	64	1·3	70	1·0	68	1·0	59	1·0	48	0·6	36	1·0	27	1·5	47	11
Hudson's Hope (Peace R.)	1	1·6	8	0·6	21	1·3	41	0·6	49	1·6	54	2·0	59	3·4	59	1·8	51	1·5	40	1·0	20	1·3	11	1·2	34	18
Dawson City (Yukon)	−22	0·8	−12	0·7	4	0·5	28	0·6	46	0·9	57	1·2	59	1·5	54	1·4	42	1·5	26	1·1	1	1·1	−11	1·0	23	13
Good Hope (Arctic Circle)	−23	0·5	−18	0·5	−10	0·6	14	0·5	38	0·6	54	1·0	60	1·4	53	1·6	39	1·1	21	1·0	−6	0·7	−21	0·5	17	10

CHAPTER V

SOILS AND NATURAL VEGETATION

PART I

SOIL CLASSIFICATION [1]

THE systematic study of soils is a recently developed branch of the natural sciences. Until a few decades ago the classification of soils was based upon the underlying rock formations. We learned that siliceous rocks tended to give rise to sandy soils of low fertility, shales gave rise to clay soils, while the dark soils on basaltic lavas were of greater fertility, &c. These principles are still accepted in part, especially with regard to *young* soils; but where soils are *mature*, i.e. have been in place for a long time, it is found that climatic factors, especially rainfall, have determined the chief characteristics. Immature soils, in the process of developing from the underlying rocks, agree fairly closely with the geological map, but the distribution of mature soils tends to conform with that of climatic and vegetational zones.

The foundation of Pedology (the modern science of soils) was laid by Russian scientists in the 1870's. Travelling over the vast Russian territory they noticed that in the north under forest vegetation the soils were ashy-grey (Podzols), while in the south the soils of the grasslands were black (Chernozems), regardless of the rock from which they were formed. Later they noted that not only the surface, but the sub-surface portions also, had characteristic features which were dependent upon climate. Examined in section each soil is seen to be made up of separate zones which the pedologist has called *horizons*. It would be improper to call them layers, for they have developed in, rather than having been added to, the soil. The face of the section is known as the soil *profile*. Essentially, a soil consists of two portions; (*a*) the surface or top soil from which constituents are being removed by the percolating rainwater; (*b*) the subsoil zone in which materials are being accumulated. The former is known as the *eluvial* or A horizon, while the latter is called the *illuvial* or B horizon. Below these is the sub-stratum of unaltered *parent material* or C horizon.

[1] My colleague, Professor D. F. Putnam—an authority on pedology—has collaborated in the section on Soils. Parts I and IV are from his pen.

Fig. 34 summarizes the profile differences of soils formed under different environments. Great contrast is to be seen between soils formed beneath forest cover and those of open grasslands. Forest soils are light in colour and contain low amounts of incorporated organic matter or *humus*, and the horizons are usually sharply distinguished. The dominant movement of water is downward, lime and other bases are leached out, the surface soil is *acid* and oxides of aluminium and iron accumulate in the profile. Grassland soils are dark, often black, with deep surface horizons and a high content of well-incorporated humus. Throughout much of the year the

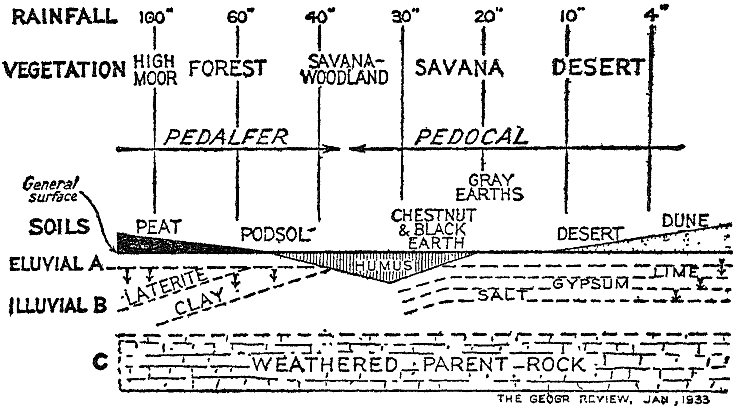


FIG. 34.—A generalized diagram showing the relation of the soil groups to rainfall. The characters of the three major profiles A, B, C, are indicated. (After Neustruev and Prescott)

movement of soil water is upward, bringing with it lime and other soluble salts which accumulate in the soil profile, giving rise to an alkaline reaction. Marbutt, the late chief of the United States Soil Survey, made these differences the basis of his classification. To the former group, he gave the name *Pedalfers* (meaning iron and aluminium soils), the latter he called *Pedocals* (calcium soils).

Under desert conditions profiles are very shallow and lime, gypsum and other 'perspiration products' accumulate at or very near the surface (Fig. 34). Sand, also, is drifted over the surface in very dry regions. On the other hand, in very wet areas, plant residues are only very slowly converted to humus, and accumulate upon the surface as *peat*.

The Pedalfers include the Grey Forest soils or Podzols, the Brown Podzolic soils, the Grey-Brown Podzolic soils, the Red and Yellow soils, and the Lateritic soils. The Pedocals include the Black earths or *Chernozems*, the Dark Brown or Chestnut soils, the Brown soils and the Grey soils of the deserts or *Sierozem*. The

Prairie soils are an intermediate group which look like the Black grassland soils, but do not accumulate lime and tend to be leached like the Pedalfers. In Canada there are examples of all of the above zonal Great Soil Groups, except the Lateritic, the Red and Yellow, and the extreme desert types.

In addition to the zonal groups with mature profiles, there are many associated groups in which the development of the profile has been inhibited by a high-water table or excess alkalinity or salt content. Such soils are called *Intrazonal.* In humid regions these immature soils are mostly *Bog* and *Half-bog* types while in the semi-arid grasslands there are saline soils or *Solonchak* and alkali soils or *Solonetz.*

Soil reaction, that is its acidity or alkalinity, is highly important as an indicator of the presence and availability of substances required for plant growth. Reaction is determined by the hydrogen ion concentration which is measured in terms of the *p*H scale. The neutral point, 7·00, is the *p*H of pure water. Soils may range from *p*H 4·00, which is very acid, to *p*H 8·00, which is quite alkaline.

The Great Soil Groups may be further subdivided into *families*, *series*, and *types.*[1] Of these, the *series* is the fundamental taxonomic unit. It includes all soils which have the same kind of profile with a definite arrangement of horizons, developed upon the same kind of parent material. Each series is given a geographical name, usually that of the county or township in which it was first identified. Within the series there are slight differences in the texture of the surface soil. The texture identifies the type. Thus the *Huron series* includes both *Huron clay loam* and *Huron silt loam.* On the other hand, series with similar profiles developed upon similar parent materials may be grouped together as a *family.*

Soil Geography

Where he can do so, the soil surveyor maps accurately the area occupied by a single series or type. Often, however, the areas are small and intimately related to small areas of other soil types. These cannot be shown, except on very large-scale maps, so the surveyor draws a line around the variegated area and labels it with the name of the dominant type. The same principle is followed in the making of small-scale regional maps. Such composite map units are sometimes called *associations.* It is thus, at all times, necessary to keep in mind the differences between the scientific classes of soils, and map units which may be used to chart their distribution.

Canadian systems of soil classification and mapping are based upon those used by United States Department of Agriculture but

[1] See ‘ Soil Classification ’ by Mark Baldwin, Charles E. Kellogg, and James Thorp. In ‘ Soils and Men ’, *U.S.D.A. Yearbook,* 1938.

they have been modified by the workers in each province to suit their own convenience. Although soil surveys have, for some time, been in progress in each of the nine provinces and numerous county or district maps have been completed, there is, unfortunately, no general study of the soils of Canada. Lacking this basis, it is proposed to set forth in some detail the soil geography of three representative areas: southern Saskatchewan, the Fraser Delta in British Columbia, and southern Ontario. From this treatment it is hoped that some of the more general effects of the soil factor in Canadian geography may be inferred.

PART II

SOILS OF SOUTHERN SASKATCHEWAN

The greatest asset in the Dominion is the wide area of the Prairies with their fertile dark-coloured soils. These soils and the grasslands under which they have developed are associated with the rather low rainfall in the centre of the continent, as indicated in Fig. 26. This relationship, however, is only partial, being modified by the effect of temperature upon evaporation. Thus the best grassland soils, the Chernozems or Black Earths, are found between the 25- and 30-inch isohyets in Texas and near the 20-inch line in south Dakota; but in Canada, where the evaporation is lower, somewhat similar soils are found under rainfalls of 15 to 17 inches. In the north, with still lower evaporation, forest trees are enabled to compete with the grasses and grey wooded soils are found.

Alone of all the provinces of Canada, Saskatchewan has made a complete general study of the soils of its settled areas. This excellent work [1] now in its second edition [2] forms the basis of the present discussion. In general, the soil zones of the Prairie Provinces form concentric arcs about the arid area of south-western Saskatchewan and south-eastern Alberta. The four main belts, the *Brown Soil Zone*, the *Dark Brown Soil Zone*, *Black Soil Zone*, and the *Grey Soil Zone* thus cross the province from north-west to south-east in accordance with the main physical controls (Fig. 35.). The inlier of Dark Brown soils is due to the greater elevation of the Cypress Hills. There is also a discontinuous transition zone of *Degraded Black Soils* between the *Black* and *Grey* Soil Zones.

Within the soil zones the Saskatchewan workers have delimited smaller areas on the basis of soil development as expressed in the

[1] Joel, A. H., Mitchell, J., Edmunds, F. H., and Moss, H. C., 'Reconnaissance Soil Survey of Saskatchewan', *Soil Survey Report No. 10*, Saskatoon, 1936.

[2] Mitchell, J., Moss, H. C., Clayton, J. S., and Edmunds, F. H., 'Soil Survey of Southern Saskatchewan, Townships 1–48 inclusive, *Soil Survey Report No. 12*, Saskatoon, 1944.

profile. In the earlier edition these were called *series*, but in the later edition of the bulletin the term *association* has been adopted, in recognition of the fact that many profile types may be associated within a soil area, and only one of them can belong to the dominant taxonomic series. In the following paragraphs the soil zones and the soils of the constituent areas are briefly discussed.

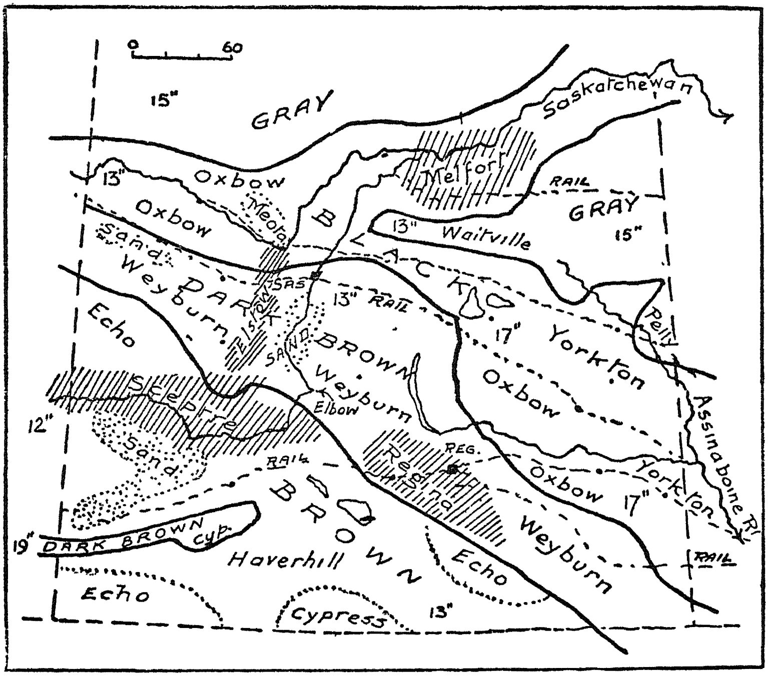


FIG. 35.—The Four Soil Divisions of southern Saskatchewan, subdivided into minor divisions. The best soils (due to former lakes) are shown by diagonal ruling. (Based on data by Joel, Mitchell, Edmunds, and Moss)

The Brown Soils.—In the south-western corner of the province lies the Brown Soil Zone, an area of 20 million acres corresponding to the 'short-grass' prairie region. Here the low moisture supply has permitted the growth of a relatively sparse cover of natural vegetation including: Blue Grama Grass (*Bouteloua gracilis*), June Grass (*Kohleria gracilis*), and Spear Grass (*Stipa comata*). The surface soils are drab brown in colour and the content of organic matter is relatively low. At the base of the profile, usually at a depth of 10–18 inches below the surface, is an horizon of lime accumulation (see Fig. 37A). The dominant soil series are the *Sceptre*, *Haverhill*, and *Echo*.

The *Sceptre* soils occupy an area of 2 million acres along both sides of the South Saskatchewan River (Fig. 35). They are derived from post-glacial lake deposits and have very heavy (clay or heavy clay) surface soils, although of a very granular structure. Natural fertility is high and they resist drought well. With a moderately undulating surface and freedom from stones, these lands are well suited for tractor farming. Spring wheat is the main crop, usually alternated with summer-fallow in a two year rotation.

The *Haverhill* soils dominate an area of about 8,500,000 acres of rather rolling morainic upland. Clay loams and loams are most common but there are many associated areas of lighter texture. Drainage is fair but alkaline sloughs (swamps) are not uncommon. Stones may be abundant. Wheat is grown on the heavier soils, but the lighter soils drift readily after cultivation and are better adapted to grazing. Water erosion is also common on the slopes.

The *Echo* soils are found south and west of the Frenchman River, south and south-west of Kerrobert, and in the Central Butte district. They occupy about 1,500,000 acres. The parent material is a glacial till, somewhat influenced by the underlying Cretaceous shale which has a marked content of ' alkali ' salts. The soil profile is of the Solonetz type with a heavy, impervious B horizon. Very often the surface soils suffer from wind erosion with the formation of numerous ' burn-out ' areas which limit the agricultural usefulness of these soils.

The Dark Brown Soils.—The *Dark Brown* soils are also found under open grasslands, but with better moisture conditions and a heavier cover of vegetation. The same ' short-grass ' species are found here together with taller ones such as Northern Wheatgrass (*Agropyron dasytachyum*) and Rough Fescue (*Festuca scabrella*). The surface soils are somewhat deeper and contain more organic matter than the Brown soils, while the horizon of lime accumulation is usually found at a depth of 10 to 18 inches. The most important series are the *Weyburn*, *Regina*, and *Elstow*. The total area of the zone is about 19 million acres.

The *Weyburn* soils are most widespread of the *Dark Brown* soils, occupying an area of more than 7,750,000 acres. They have developed upon glacial till with a somewhat more favourable topography than the Haverhill soils, but stones are a serious problem. Wheat is the chief crop but, toward the moister margin, coarse grains and forage crops become important (Fig. 35).

The *Regina* soils are found on the ' Regina Plains ', the bed of a large glacial lake which occupied this region when the Saskatchewan drainage was blocked by ice. Smaller tracts occur in other parts of the zone, bringing the total area to over 2 million acres. The smooth, nearly level topography and stoneless surface permit a

high percentage of arable land and large, mechanized farms. The well-drained Regina heavy clays are the best wheat lands in the province.

The *Elstow* soils are developed upon silty lacustrine deposits often underlain at shallow depths by boulder clay. Over 2,250,000 acres have been mapped, chiefly to the west and south-west of Saskatoon. Solonetz-like profiles are characteristic. Wheat is the dominant crop.

The *Cypress* soils are found chiefly on the plateau or 'bench' lands of the Cypress hills, the parent materials being Tertiary sediments slightly modified by glaciation. The plateau is surrounded by plains with Brown soils but because of its elevation and resultant more humid climate it is an outlier of the Dark Brown Soil Zone.

The Black Soils.—The Black soils are found under the 'tall-grass' cover of the 'Park' belt. Here we find wheatgrasses (*Agropyron* spp.), Brome grasses (*Bromus* spp.), reedgrasses (*Calamagrostis* spp.), and in the 'bluffs' interspersed throughout the area are such trees as aspen (*Populus tremuloides*), black poplar (*P. balsamifera*), Saskatoon berry (*Amelanchier alnifolia*), and various willows (*Salix* spp.). These clumps of trees are indicative of increasing moisture supply. The surface soils are very dark and contain more organic matter and nitrogen than those of the other zones. The horizon of lime accumulation, also, lies at a greater depth, usually 15 to 30 inches. (See Fig. 37A.) The Black soils occupy an area of 16,500,000 acres.

The *Oxbow* soils, occupying more than 6,750,000 acres, constitute the most widespread association of the Black Soil Zone. The parent material is glacial till and the topography has the characteristic 'swale and swell' of ground moraine. Stones are a nuisance. Wheat is still the most important crop, although coarse grains and forage crops are important. Oxbow loams are not subject to severe drifting, but water erosion may become serious (Fig. 35).

The *Yorkton* soils occupy over 1,800,000 acres of undulating land in which small depressional areas are of frequent occurrence. The A horizon is unusually deep, often 14 inches or more, and lime may be present at the surface. The better-drained areas are highly productive.

The *Blaine Lake* soils, occupying about 1,200,000 acres, are characterized by varying degrees of Solonetzic development, and occur on shallow glacial lake deposits from North Battleford east. The area contains some excellent agricultural land.

The *Melfort* soils occupy an area of about 600,000 acres, chiefly in the Carrot River Valley. They are developed on heavy laminated

clays laid down in a western extension of Lake Agassiz. They are very fertile and produce high yields of both grain and forage crops.

The *Meota* soils (836,000 acres) are formed upon sandy alluvium.

The Grey Wooded Soils and **Degraded Black Soils.**—North of the grasslands is the Grey Soil Zone. The soils are developed under a woodland vegetation in which the dominant trees are poplars (*Populus tremuloides* and *P. balsamifera*), Spruce (*Picea* spp.), jackpine (*Pinus Banksiana*), tamarack (*Larix americana*), willows (*Salix* spp.), and canoe birch (*Betula papyrifera*). A thin leaf mould overlies a grey-leached upper horizon, typical of the Podzols. In spite of this, there is often an horizon of lime accumulation at the base of the profile (Fig. 37A).

The *Waiteville* soils are the most extensive of the Grey soils yet mapped. They occupy nearly 1,750,000 acres. The parent material is a stony till. Due to podzolization, they are low in organic matter and general fertility, although not excessively acid. They produce wheat of low protein content, and are used for coarse grains, alfalfa, and other forage crops.

The *Degraded Black* soils occupy an irregular transition belt of some 3 million acres, in which the forest has invaded the margin of the grasslands.

The *Whitewood* soils, with an area of over 1,100,000 acres, are developed on glacial till and represent a transition from the Oxbow (with a typical Black soil profile) to the Waiteville, a Grey soil. Taken as a whole, they have similar crop adaptations to the Oxbow soils (Fig. 35).

The *Pelly* soils (315,000 acres) occur in the east and represent a degraded Yorkton condition.

The *Shellbrook* (475,000 acres) consist of light-textured soils developed upon sandy alluvium.

The *Tisdale* soils (515,000 acres) are found in the more heavily wooded sections of the Carrot River valley, north and east of the area of Melfort soils. They may be regarded as deep black soils like the Melfort which have undergone woodland invasion and 'podzolic degradation'. They have similar agricultural uses.

Agricultural Resources.—The importance of the soil cannot be overemphasized. Particularly is this so in the province of Saskatchewan, which is the most rural and most dependent upon agriculture of the nine provinces. In recent years Saskatchewan soils have produced farm products to the value of nearly $500,000,000 per annum, running a very close second to Ontario. But, whereas Ontario has a manufacturing industry which overshadows its agriculture by a ratio of about 4 to 1 in value, the reverse is the case in Saskatchewan.

Soils are extremely uneven in their productive capacities. In southern Saskatchewan a total of 60 million acres have been surveyed and classified on the basis of suitability for wheat production :[1]

LAND CLASSIFICATION IN SASKATCHEWAN

Class	Approximate acreage	%
Best wheat lands	4,275,000	7·1
Very good wheat land	3,558,000	5·9
Moderately good wheat land	10,182,000	16·9
Fair wheat land	15,309,000	25·5
Total arable land	33,324,000	55·4
Unsuitable for cultivation	26,905,000	44·6
Total	60,229,000	100·0

Saskatchewan grows from 10 million to 15 million acres of wheat and about 10 million acres of other crops each year. It is easy to see that soil knowledge is highly necessary in the formulation of her agricultural policy. The folly of not knowing has been proven past all doubt in recent years when hundreds of thousands of acres, once cultivated, have been returned to grass under the P.F.R.A. (Prairie Farm Rehabilitation Act).

PART III

SOILS OF THE LOWER FRASER VALLEY

More than half the population of British Columbia live in the urban and rural municipalities of the Lower Fraser valley. Fort Langley, about 25 miles from the mouth of the river, was the site of the first farming operations in 1827. In 1860 a larger settlement was founded near the Stave River and in 1862 farmers began to locate near Chilliwack. The open meadows of the flood plain required little clearing, but they were subject to flood. Dyking, began in 1864, was completed in 1903, after which the region developed rapidly. Recently, because of the needs of the specialized fruit and vegetable industry, the soils of this area, amounting to about half a million acres, have been surveyed and a map and descriptive bulletin issued.[2] Some of the information is briefly summarized in the following paragraphs.

The Lower Fraser Region may be divided into three sections based on physiography and agricultural development (Fig. 36). First of these is the area underlain by the recent alluvium of the

[1] *Thirty-ninth Annual Report of the Department of Agriculture of the Province of Saskatchewan*, Regina, 1944.

[2] Kelley, C. C., and Spilsbury, R. H., ‘ Soil Survey of the Lower Fraser Valley ’, Publication 650, *Technical Bulletin 20*, Dominion of Canada Dept. of Agriculture, Ottawa, 1939.

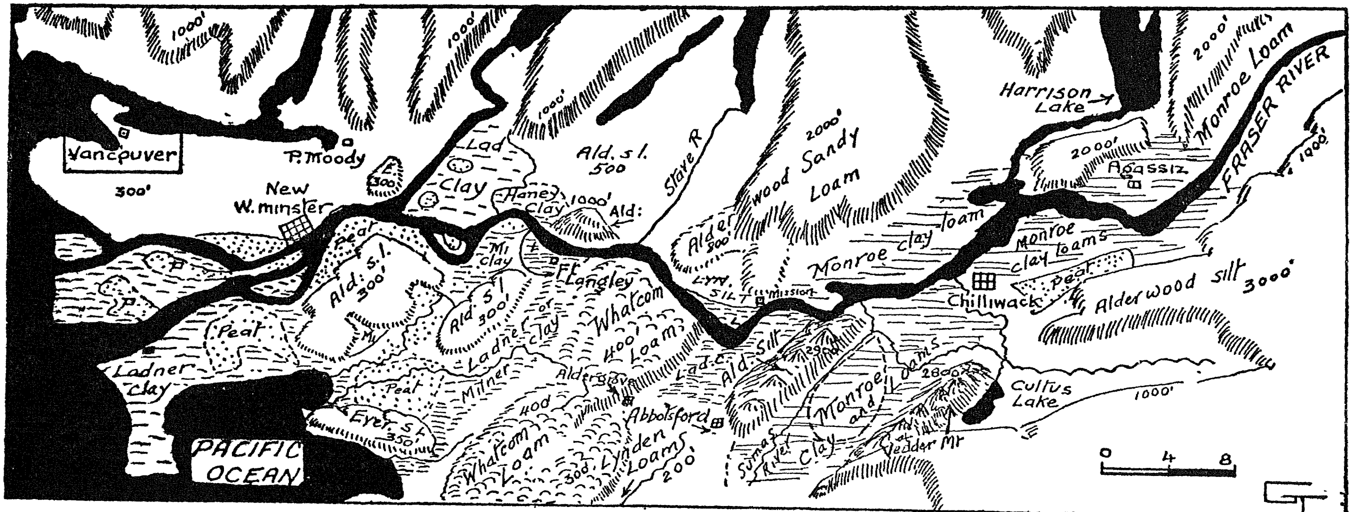


FIG. 36.—Soil characteristics in the large area of agricultural land in the Fraser Delta. The divisions are based on data by Kelley and Spilsbury

' Recent Delta ' and flood plain. Its elevation is less than 25 feet above sea level and it is dyked against floods. The soils have been classified as Monroe and Ladner clays, and there are extensive peat bogs. This is the most productive agricultural area. The Fraser Delta is still being extended seaward at the rate of about 10 feet per year.

The second section is the ' Raised Delta ', having the same origin but now standing from 25 to 150 feet above sea level. Its topography is undulating to gently rolling. Here the Langley, Milner, Haney, and Custer soils have been mapped. It is second to the ' Recent Delta ' in agricultural development.

The third section is the ' Upland ', with rather rugged relief, ranging up to 900 feet above sea level. The soils are developed upon a parent material of glacial till, with frequent rock outcrops at higher elevations. This area is still largely forest covered. Here the Everett, Lynden, Alderwood, and Whatcom series have been mapped (Fig. 36).

Soil Development and Classification

Soil development of the region is conditioned by its marine west coast climate with its mean January temperature of 36° F. and a July mean of only 63° F. The rainfall is extremely seasonal, with over 8 inches in each of the winter months and less than 2 inches in July and August. The natural climax vegetation was a heavy forest of Douglas fir (*Pseudotsuga taxifolia*), Western Hemlock (*Tsuga heterophylla*), and, in swampy places, Western Red Cedar (*Thuya plicata*). Now, however, the upland is covered by a luxuriant second growth of shrubs, bracken, alder, and vine maple. The flooded lowland bears groves of black cottonwood (*Populus trichocarpa*), open meadows, and peat bogs.

Under these conditions the normal *zonal* soils are definitely podzolic with a shallow leached horizon. There is, however, a very slight development of the B horizon. The colours of the zonal soils are reddish or yellowish brown, probably because of the accumulation of iron oxide, thus showing a relationship with the lateritic soils of warm climates. This tendency toward laterization is probably encouraged by periods of midsummer drought.

In parts of the Raised Delta and Lowland areas, drainage is imperfect and zonal soils do not form. Here *intrazonal* Groundwater Podzols and Half-bog types are found.

The materials of the Recent Delta have not been in place long enough to exhibit any trace of profile formation. These soils are therefore said to be *azonal.*

The soil classification and other information about the soil areas is given in the accompanying table.

SOILS OF THE FRASER VALLEY

Classification	Elevation (feet)	Land form	Parent material	Locality	Area in acres
I ZONAL PODZOLIC SOILS:					
1. With excessive subdrainage—					
(*a*) Everett Series	< 300	Abandoned shore terraces	Water-worked glacial drift	Whiterock	31,454
(*b*) Lynden Series	175–500	Old river terraces	Stratified sand and gravel	Blaine, Mission, Abbotsford	35,549
2. With restricted subdrainage—					
(*c*) Alderwood Series	50–900	Rough hills and mountains	Shallow alluvium over hard till	Widespread on high slopes	116,106
(*d*) Whatcom Series	< 400	Low hills	Old indurated delta deposits	Aldergrove, Haney, Ruskin	67,747
3. With fair drainage—					
(*e*) Milner Series	25–150	Gently rolling valley floors	Delta clay	Near Langley	10,508
(*f*) Haney Series	25–150	Gently rolling lowlands	Delta clay	Port Haney	4,664
II INTRAZONAL SOILS:					
4. Groundwater Soils—					
(*g*) Custer Series	25–50	Low terraces	Loamy sand underlain by clay	Langley Prairie	3,800
(*h*) Langley Series	25–50	Old river channel floor	Grey clay	Langley Prairie	6,232
5. Peat Bog	various	Shallow depressions	Sphagnum moss peat	Lulu Island, Ladner, Chilliwack	50,890
III AZONAL SOILS					
6. Recent Alluvium—					
(*i*) Monroe Series	< 30	Flood plain	Alluvium	Chilliwack	89,338
(*j*) Ladner Series	± sea level	Delta plain	Alluvium	Ladner to Mission	95,293
Miscellaneous Areas	—	—	—	—	33,116
TOTAL AREA					544,697

The following notes on the various soils will be found of interest.

Everett.—These soils, formed upon glacial deposits which have been modified by wave action, are very sandy and do not hold water well. Droughtiness is indicated by the growth of lodgepole pine. Everett soils are not recommended for agricultural use (Fig. 36).

Lynden.—Lynden soils are found on old river terraces, they are similar to Everett soils and have the same drawbacks. Only the Lynden silt loam (11,000 acres) near Mission and Abbotsford is to be recommended. Some small fruits and vegetables are grown.

Alderwood.—On the whole Alderwood soil areas are too rough for agriculture, but in one or two favoured localities there is some part-time farming.

Whatcom.—In spite of the impervious subsoil, Whatcom silt loam will probably become used extensively because of its favourable texture and topography. Clearing, however, is expensive, and lime and fertilizers are necessary in order to grow good crops.

Milner and *Haney.*—These are heavy (clay loam and clay) soils developed upon similar delta deposits and of similar usefulness, although the Milner clay loam is slightly less acid and more fertile. Both areas are well settled. The agriculture consists of mixed farming, dairying, poultry, and fruit growing (Fig. 36).

Custer.—Custer loam is a groundwater podzol with a horizon of 'ortstein' or bog iron at about 12 to 16 inches. About 75 per cent of the area has been cleared and used for general farming. Drainage is necessary, and lime and fertilizers must be applied to produce good crops.

Langley.—Langley clay loam belongs to the 'Wiesenböden' or black meadow soils, developed under grasses and sedges in poorly drained areas such as Langley Prairie. This was the first soil to be farmed and it is still regarded as the most productive soil in the region. It is all under cultivation or in pasture.

Monroe.—Monroe clay loam is the most important type of this series. An area of 34,000 acres surrounds Chilliwack and is the main economic support of the city. Dairying is important and large areas of hay and ensilage corn are grown. Fruits, tobacco, hops, and potatoes are also produced.

Ladner.—The Ladner clay area is flat, below freshet level in the east and below high tide in the west. It has therefore been dyked from the days of the earliest settlements. Drains and pumping stations have to be provided to keep the water level low enough for the growth of crops. Farms are large, grain growing and dairying are the chief enterprises, but small vegetable farms are found near Vancouver. In spite of the high crop yields, the

nutritional value is sometimes low and mineral supplements must be fed to livestock in the area.

The Peat areas that are associated with the Monroe and Ladner soils cover 51,000 acres. The Delta Bog near Ladner covers 22,000 acres and averages 8 feet in depth. Large areas have been reclaimed for pasture and crops. Colonies of Oriental gardeners produce a great variety of truck crops and small fruits on peat lands. On Lulu Island a factory has been established to manufacture peat products, while commercial peat moss is harvested from other bogs as well (Fig. 36).

Agricultural Resources.—Slightly over half a million acres of soil have been surveyed in the Lower Fraser valley; of this about 318,000 acres or 58·4 per cent is thought to be capable of agricultural development. It is natural in any newly settled country for the best lands to be settled first and the better half of this area is already settled. Farms are small (average 35 acres) and highly capitalized, and they are specialized toward the production of small fruits, vegetables, and dairy produce to supply the urban demand. As that demand grows, more land must be brought under cultivation and, more and more, soil knowledge must be brought to bear upon the problem of locating new enterprise.

PART IV

THE SOILS OF SOUTHERN ONTARIO

That portion of Old Ontario lying to the south of the Canadian Shield, and elsewhere in this book referred to as 'the central "Toronto" District' and 'Ontario Peninsula', is one of the most populous portions of the Dominion and the possessor of the most diversified agricultural resources. This is due, not only to its position as the southernmost projection of the Canadian national area, but also to the natural fertility and durability of its soils.

No general account of the soils of this area has yet been published, but soil survey parties have been at work for over twenty years. Some 24 counties have been examined and soil maps have been issued for 6 of them, while manuscript maps for most of the others have been made available through the kindness of Professor F. F. Morwick of the Ontario Agricultural College. In addition, the whole area has been investigated by Mr. L. J. Chapman of the Ontario Research Foundation and Professor D. F. Putnam of the Department of Geography, University of Toronto, and a number of papers on the land forms, soil materials, and land types have appeared during the past ten years.*

* See note next page.

Recently, also, there has appeared an interesting article by Mr. G. A. Hills of the Ontario Department of Lands and Forests dealing with the soil zones of the whole province.[1]

The climate of southern Ontario,[2] with its adequate and uniform rainfall is such as to produce a luxuriant mixed coniferous-deciduous forest and to encourage the podzolic weathering of soils. The zonal soils are not Podzols, however, but Grey Brown Earths. The boundary of the zone is rather sharply defined at the edge of the Shield (Fig. 38), since the limy materials derived from the Paleozoic rocks of the area tend to inhibit podzolization; whereas the siliceous debris from the Pre-Cambrian rocks has the opposite effect.

As in the portions of western Canada just discussed, the surface geological deposits, that is the parent materials from which the soils are formed, were all laid down during the waning of the Pleistocene glaciers, either directly by the ice itself, or as re-sorted sands, silts, and clays by the waters of the high-level forerunners of the Great Lakes. The complexity of these materials, including sandy waste from the Shield with clay and lime from the Paleozoics, has given rise to a great number of mature soil types. There is the additional factor in that the glaciated terrain is physiographically very young, so that there are many undrained flats and depressions which contain wet intrazonal soils, i.e. Bog and Half-bog types. Moreover, much of the glacial till, and even some of the lacustrine sediments, are so high in lime that there has not been time enough since the Ice Age for complete Grey Brown Podzolic development, and intrazonal Brown Forest Soils have resulted.

In brief, then, we would point out that the Grey Brown Podzolic soils with their well-developed and differentiated A_1, A_2, and B horizons (Fig. 37C) occur on the well-drained uplands of mixed calcareous debris. Towards the north, and at the highest elevations in Peninsular Ontario, both climate and soil material tend towards stronger leaching. The Brown Podzolic soils (Fig. 37B) show little differentiation in the A horizon, but approach closely to the

* Putnam, D. F., and Chapman, L. J., 'The Physiography of South-Central Ontario', *Scientific Agriculture 16*, pp. 457–77, 1936.

Chapman, L. J., and Putnam, D. F., 'The Soils of South-Central Ontario', *Scientific Agriculture 18*, pp. 161–97, 1937.

Chapman, L. J., and Putnam, D. F., 'The Physiography of South-Western Ontario', *Scientific Agriculture 24*, pp. 101–25, 1943.

Putnam, D. F., and Chapman, L. J., 'The Drumlins of Southern Ontario', *Transactions Royal Society of Canada*, Sec. IV, pp. 75–88, 1943.

[1] Hills, G. A., Pedology, 'The Dirt Science', and 'Agricultural Settlement in Ontario', *Canad. Geog. Jnl.*, XXIX, pp. 106–27, 1944.

[2] Putnam, D. F., and Chapman, L. J., 'The Climate of Southern Ontario', *Scientific Agriculture 18*, pp. 401–46, 1938.

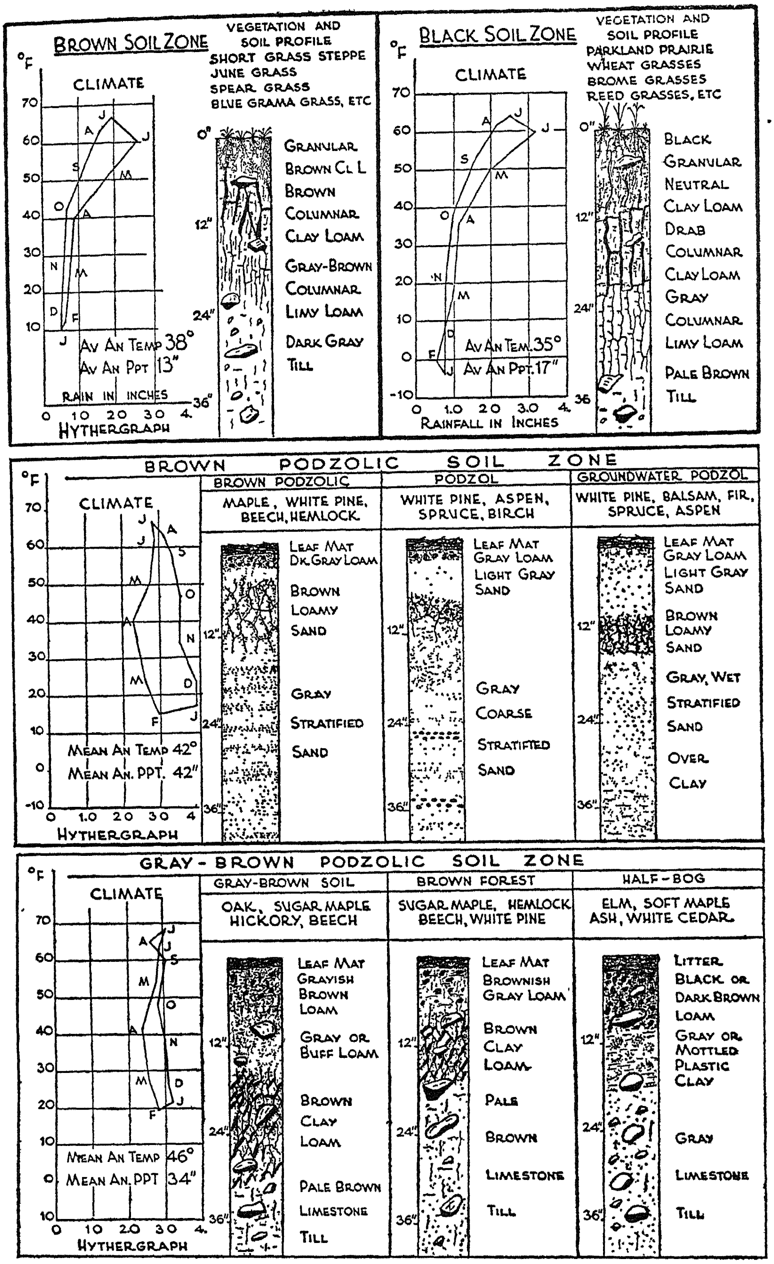


FIG. 37A.—Generalized diagrams of grassland soils developed upon glacial Till in southern Saskatchewan, showing also hythergraphs and dominant trees. (Hythergraphs are explained in Fig. 59)

FIG. 37B.—Similar diagrams of soils developed on sandy materials in the Brown Podzolic Zone of southern Ontario

FIG. 37C.—Similar diagrams of the soils developed upon Loamy Limestone Till in southern Ontario. (All due to D. F. Putnam)

podzols in the accumulation of iron oxide in the B. The Podzols (Fig. 37B) are distinguished by a shallow A_1, a strongly leached, grey, and sometimes deep A_2 horizon and a reddish-brown B. The Brown Forest soils as a rule have a shallow profile, with no differentiation of the A_2 horizon, the whole profile, A and B, often being less than 1 foot deep. The Half-bog soils occur mainly in the flat lacustrine plains, although also in the flat and depressional areas of the till plains (page 82). The profile modifications, induced by restricted drainage, range from a slight orange and grey mottling of the subsoil, to a complete suppression of horizontal development. In the latter cases there is usually several inches of decomposed organic debris on the surface, underlain by a bluish or greenish-grey clayey material known as *glei*. In the intermediate situations, the organic matter is well mixed with the mineral soil and a *mull-glei* profile results. The Ground-water Podzols occur in the Sand plains with a high-water table, the striking feature of their profiles is the induration of the B horizon, under the influence of iron and humus, to form a 'hardpan' or *ortstein*, as it is known to pedologists, sometimes several inches thick. The *Wiesenböden*, or Black Meadow soils, are found in the south-western corner where the climate closely approaches that of the prairie regions of the north-central states. Here in a small area around Lake St. Clair the soils were formed under a meadow vegetation of grass and sedge, though later invaded by swamp forest. The surface is deep black in colour and may extend to 18 inches in depth before reaching the glei horizon. Most of the Bogs are of the flat type where the water is continually at the surface, but in the uplands near Georgian Bay a number of raised bogs may be encountered (Fig. 37B).

Glacial Features

At the climax of the Wisconsin glaciation, ice covered all of eastern North America as far south as the Ohio Valley. All of Ontario was deeply buried. As the ice sheet thinned, the first land to be uncovered was the upland of 'Peninsular Ontario'. To this ice-locked plain, F. B. Taylor [1] gave the name 'Ontario Island'. The drainage escaped between the noses of the Huron and Ontario–Erie ice lobes towards Ohio in what was termed 'the Crease River' (Fig. 54). The ice thinned and shrunk still further into the lake basins and all of 'Peninsular Ontario' was free of ice and high-level lakes, with drainage to the south, occupied the Great Lakes basins. Then came a readvance and the ice closed in about 'Ontario Island' forming the concentric ridges of the *Horseshoe Moraines* (Fig. 38). Accompanying these is an exceptionally well-developed series of

[1] Taylor, F. B., 'The Moraine Systems of South-western Ontario', *Canadian Institute Transactions 10*, pp. 1–23, 1913.

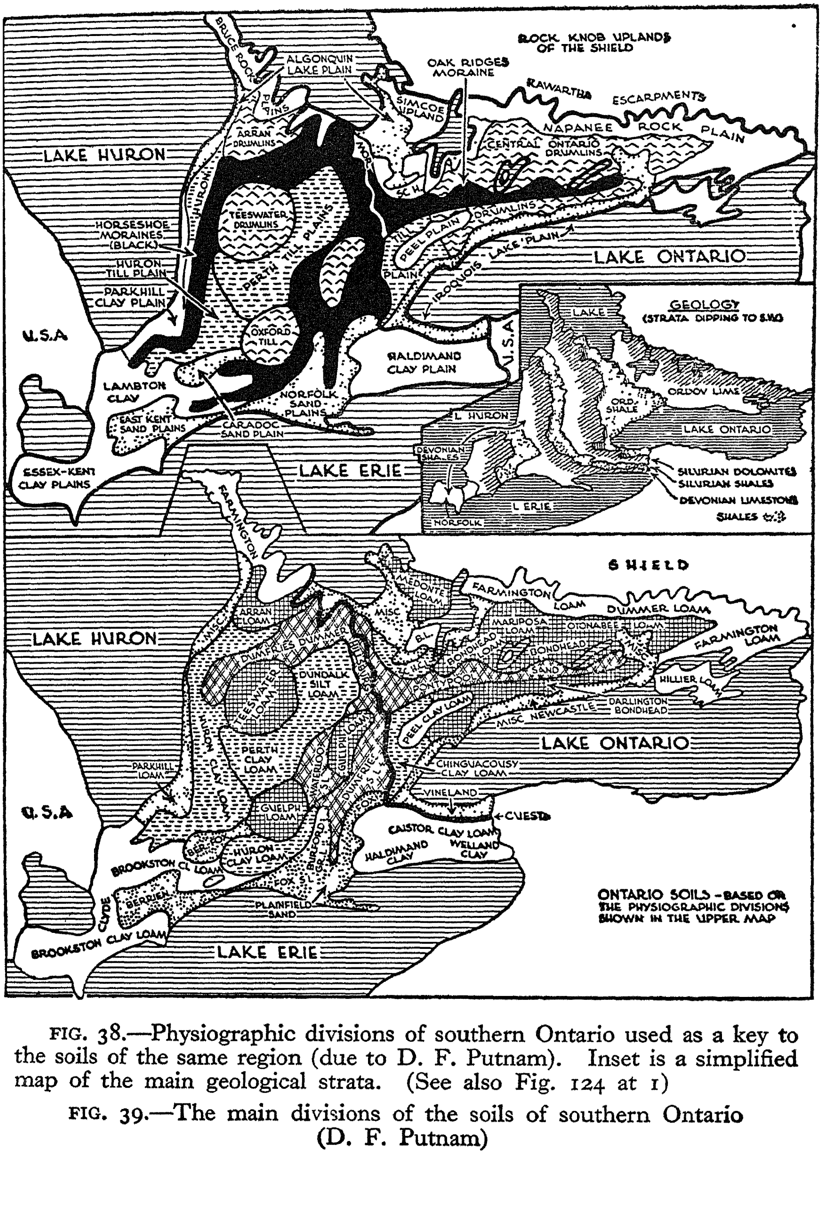


FIG. 38.—Physiographic divisions of southern Ontario used as a key to the soils of the same region (due to D. F. Putnam). Inset is a simplified map of the main geological strata. (See also Fig. 124 at 1)

FIG. 39.—The main divisions of the soils of southern Ontario (D. F. Putnam)

spillways, now occupied by parts of the Grand, Thames, Maitland, and Saugeen River systems.[1] The chief member of the 'Horseshoe' is probably continuous with the Port Huron Moraine System of Michigan [2] and marks the boundary between Early and Late Wisconsin deposits. The Lake Erie basin was occupied by a succession of high-level lakes which flooded large areas of 'Peninsular Ontario'; the most important of these was Lake Warren, the shore-line of which can be traced from just north of Hamilton almost to Owen Sound, a distance of 300 miles.[3] It may be considered as the boundary between the till uplands and the lacustrine plains.

When the ice retired below the Niagara Escarpment, it divided into two lobes: the Georgian Bay–Lake Simcoe to the north and the Ontario in the south. Between the two the 'Oak Ridges' interlobate moraine was formed.[4] As the ice waned still more, several temporary lakes occupied the areas between the ice and the moraine. To the more important of these the names *Schomberg* to the north of the ridge, and *Peel* to the south, have been given.[5]

After the ice left this region altogether, it still remained in the St. Lawrence valley for several thousand years. During that time the Ontario basin was occupied by Lake Iroquois, of which Dr. A. P. Coleman [6] has given an excellent account. The Lake Huron–Georgian Bay basin was occupied by a very large body of water known as Lake Algonquin.[7] For a time its outlet was by way of the Kawartha Lakes and the Trent River into Lake Iroquois.[8] Eventually, the ice left the St. Lawrence and the sea came into eastern Ontario and even into the Ontario basin.[9] It should be noted that none of these old shore-lines has remained horizontal. The melting of the ice released a great load from north-eastern Canada and the land has risen several hundred feet in post-glacial time. Consequently, the Iroquois shore-line which is at 362 feet above sea level near Hamilton, stands at 432 feet in Toronto and 730 feet at

[1] Chapman, L. J., and Putnam, D. F., 'The Moraines of Southern Ontario', *Transactions Royal Society of Canada*, Sec. IV, pp. 33–41, 1943.

[2] Taylor, F. B., 'Correlatives of the Port Huron Morainic System of Michigan in Ontario and New York', *Amer. Jour. Sci. 237*, pp. 375–88, 1939.

[3] Chapman, L. J., and Putnam, D. F., *op. cit.*, 1943.

[4] Taylor, F. B., *op. cit.*, 1913.

[5] Putnam, D. F., and Chapman, L. J., *op. cit.*, 1936.

[6] Coleman, A. P., 'Lake Iroquois', *Ontario Department of Mines Annual Report*, Vol. XLV, Part 7, 1936.

[7] Goldthwaite, J. W., 'An Instrumental Survey of the Shorelines of the Extinct Lakes Algonquin and Nipissing in South-western Ontario', *Canadian Dept. of Mines Geological Survey Memoir 10*, pp. 1–57, 1910.

[8] Johnston, W. A., 'The Trent Valley Outlet of Lake Algonquin . . .', *Canadian Dept. of Mines Geological Survey Museum Bulletin 23*, 1916.

[9] Fairchild, H. L., 'Gilbert Gulf (Marine waters in the Ontario Basin)', *Bull. of the Geol. Soc. of Amer. 17*, pp. 712–18, 1905

Pancake Hill some 15 miles north of Belleville. The Algonquin shore-line shows a similar tilt from about 600 feet at Sarnia, to about 900 feet at Washago on the edge of the Shield (Fig. 38).

Land Forms and Soil Associations

From detailed study of the area certain land-form types can be identified and characteristic areas more or less satisfactorily delimited. Furthermore, the soil development in these areas can usually be characterized on the basis of a single type or series, or at most a soil family. However, in most cases there will be found in juxtaposition on the same material both *mature* and *immature* profiles, constituting a complex which may be termed an association in the sense in which it has been used by Professor J. H. Ellis of the University of Manitoba.[1] The distribution of the main areas of these land types is shown in the accompanying map and their chief characteristics are discussed in the following paragraphs. In addition, the important soils of the areas are also described. It must be emphasized that in such a large (15 million acres) and complex area the treatment is extremely generalized (Fig. 39).

1. *Rock Knob Uplands.*—Not actually part of the area under discussion, these rockribbed hills border it on the north and constitute one-third of southern Ontario. The soils are Brown Podzolic and Podzols ; droughty and infertile, they offer little encouragement to agriculture and have not been surveyed.

2. *Escarpment Slopes.*—The Niagara Escarpment is the most striking feature of southern Ontario, extending from Niagara Falls to the northern tip of Bruce Peninsula. It is too steep for agriculture, and, also, too steep for the formation of normal soil profiles. Minor escarpments occur elsewhere, particularly the Kawartha lying along the edge of the Shield.

3. *Rock Plains.*—Moving southward over the bordering escarpments the ice had an excellent chance for erosion and stripped rock plains are found along the margins of the Paleozoics but are particularly noticeable in the Napanee Plain at the east of our area. The outstanding soil characteristic is lack of depth, but there are variations. *Farmington loam* is found in the body of the area. It has a brown featureless profile 6 to 12 inches deep over the limestone. *Hillier loam* in Prince Edward County is deeper because there the upper strata are thinner and have shale partings and so weather more easily. *Dummer loam* is found on the rough shallow moraines just south of the Shield. It is an extremely stony soil. These are not crop lands, but are largely used for pasture.

4. *Morainic Hills.*—The *Horseshoe* and *Oak Ridges* moraines are

[1] Ellis, J. H., 'Field Classification of Soils for use in the Soil Survey', *Scientific Agriculture 12*, pp. 338–45, 1932.

dominated by, although not entirely composed of, rather light textured materials heaped up in characteristic "knob and kettle" formation. In part they may be classified as till, and in part they are watersorted. *Dumfries sandy loam* on the former and *Pontypool sand* on the latter are typical soils. They have rather featureless profiles because of the excessive drainage in the substratum. The Waterloo Hills constitute a separate morainic area in which the materials are somewhat more loamy and a typical Grey Brown profile is developed. It is classified as *Waterloo sandy loam* and is of more value for agriculture than the other morainic soils but it is highly erodable (Fig. 39).

5. *Till Plains*.—About one-third of the surface of southern Ontario is composed of ground moraine or till. It is made up of rock particles of all sizes from fine clay to huge boulders. The surface, in part, is rolling to hilly, but many smooth plains exist. In places they have been flooded for a time and covered with a veneer of clay or silt. There is, also, some windblown silt or 'loess', but in a very thin layer. The presence of shallow layers of silty material over heavy clay till is often the cause of impeded drainage and retarded development of the soil. Along with the ground moraine, it seems advisable to classify the smooth gently sloping till ridges of the waterlaid terminal moraines.

On the well-drained till plains, the soil profiles are mature and representative of the Grey Brown earths, except that towards the north and at higher elevations there is evidence of stronger podzolization and a tendency to the formation of Brown Podzolic soils. In the flatter areas, as for instance, in parts of the Perth Plain, Half-bog soils are found.

The *Huron* series may be taken as typical of this family of soils developed upon clay tills. Surface soils are clay or silt loams, pale brown in colour, and slightly acid. There is a deep clayey B horizon, sticky when wet and blocky when dry. Large areas of these soils are used for pasture since they become rather hard to work when the original store of organic matter is depleted.

6. *Drumlins*.—Drumlins are oval hills averaging about a mile in length, a third of a mile in width, and up to 100 feet in height. There are over 6,000 of them in this area. They are concentrated in fields or groups of which the following are most noteworthy: the Central Ontario Field focusing on Peterborough, the Guelph Group, the Oxford Group, the Teeswater Field, and the Arran Field. Drumlins are composed of stony till in which there is a high percentage of limestone, but not a great deal of the clay derived from shales. The soils tend to have shallow profiles with a thin brown B horizon having little clay in it. The Guelph, Teeswater, and Bondhead series are mature Grey Brown earths, but the Arran and Otonabee,

with their alkaline surface soils, belong to the Brown Forest group. They are all good agricultural soils, but there is a rather high percentage of waste land in steep slopes, stony crests and interdrumlin swamps. Erosion is a problem in many places (Fig. 38).

7. *Sand Plains.*—The sand plains are waterlaid. Extensive deltas of the Thames built into Pleistocene lakes account for the Kent and Caradoc sand plains. The Norfolk sand plains were built by the Grand, while the Camp Borden sands were laid down by the Nottawasaga. There are many smaller areas. The soils vary in texture, some of them are coarse, open, droughty, and apt to blow badly. Others are finer and make good agricultural lands. Where drainage is good, as in Norfolk County, deeply weathered zonal profiles such as Fox, Plainfield, and Oshtemo result. The gravelly portions of deltas and river terraces are usually referred to the Burford series. Restricted drainage which may be caused by a clay stratum within 4 feet of the surface causes the development of a Half-bog profile such as the Berrien which is common in the Kent and Caradoc areas. Towards the north the sand plains have *Podzol* soils (Fig. 39).

The deep sandy soils of southern Ontario were, at the turn of the century, exhausted and being rapidly abandoned. In the years since 1925 they have become the foremost tobacco-growing area of the Dominion, supplying our own requirements for flue-cured cigarette tobacco and a large export trade as well. Many other special crops are also grown.

8. *Clay Plains.*—Away from the mouths of rivers and in deep quiet water, the finer rock particles were deposited. Near the melting ice, ' varved ' or banded clays were deposited. Each summer a good deal of silty material was dumped into the lake and settled to the bottom; during the winter when the rivers ceased to flow the very fine particles were precipitated. Thus each annual varve is made up of a thick silty layer and a narrow, dense, and often darker-coloured clay layer. Not all the clay plains have deep clays, often there is only a foot or so—enough, however, to smooth out the uneven floor of the ground moraine and to interfere with the internal drainage of the soil.

Not many of the clay plains have mature soils, mostly they tend towards the Half-bog with deep mull surfaces formed under an ash-and-elm or oak-hickory vegetation. The important clay plains shown in Fig. 38 are the Essex-Kent and Lambton in the south-west, the Haldimand in the Niagara peninsula, and the Peel and Schomberg in the central district. There are many smaller ones.

Brookston clay loam is widespread in the south-western area. It is a typical Half-bog soil with a dark brown surface soil, high in organic matter and a foot or more in depth, underlain by a mottled,

sticky glei subsoil. When drained it is one of the most productive soils in Canada (Fig. 39).

Clyde clay loam is found near Lake St. Clair. Its surface is so low and flat that pumps must be installed for drainage. It belongs to the *Wiesenböden* or *Black Meadow* soils with a black, crumbly highly organic surface often 18 to 20 inches in depth. It is famous for the production of corn and sugar beets.

The *Haldimand*, *Welland*, and *Caistor* clay loams of the Haldimand Clay Plain are also Half-bog soils of various degrees. They tend towards acidity and lack lime and phosphorus. Properly fertilized, they produce good general crops and pasture.

The *Peel clay loams* are neutral in reaction and have a deep dark crumb-structured surface soil and a rather heavy, blocky subsoil. Formerly a grain- and hay-growing area supplying city demand, it is now used for alfalfa, silage corn, and pasture in a dairy economy.

Schomberg clay loam is a *Brown Forest soil* with a well-developed profile, but with free carbonates in the surface soil. It is fairly well drained but its immaturity is due to the fact that the silty clay from which it is developed contains over 50 per cent calcium carbonate.

9. *Miscellaneous Lake Plains and Bogs.*—Around the shores of Lake Ontario, Lake Huron, and Georgian Bay there are narrow plains left by the Pleistocene Great Lakes which contain a great variety of deposits. Along the old shore-lines are many wave-cut cliffs, boulder pavements, and abandoned beach ridges, while farther out is a mosaic of sand, silt, and clay which it is impossible to show on our map (Fig. 39).

There are many small areas of light-textured loams, which, because of their nearness to city markets and the freedom from frost, incident to their position on the lake shore, have become prosperous horticultural districts. The Niagara Fruit Belt, Burlington, and Humber Bay on Lake Ontario, and the Beaver Valley and Collingwood on Georgian Bay, are notable examples.

Bogs and Marshes abound in the glaciated landscape of southern Ontario, though it is hard to show them on our small-scale map. They are found in lagoons along the present lake shores, in old lake bottoms, in abandoned spillways, in glacial kettles, and in broad shallow depressions in the ground moraine. They constitute the lowest land in southern Ontario and, also, almost the highest (over 1,700 feet). Various sporadic attempts have been made to utilize them for fuel and for industrial purposes. Towards the south several of these areas have been developed as market gardens, notably the ones at Leamington and Rondeau on Lake Erie, Thedford at the southern end of Lake Huron, and Bradford at the southern end of Lake Simcoe.

Agricultural Resources.—The 15 million acres under discussion

in this section constitutes but 6 per cent of the total land area of Ontario. It is practically all occupied, making up two-thirds of the farm area of the province and accounting for an even larger proportion of the half-billion dollar annual production which makes Ontario the foremost eastern agricultural province.

The general distribution of agricultural enterprise is discussed elsewhere. Here we wish simply to point to a few instances which emphasize the soil factor. The extensive clay plains of Ontario were once exploited under an export wheat economy. They are now largely used as pasturelands for they were not well adapted to produce wheat of a high quality. Beef cattle tend to occupy the denser, harder soils, while dairy cattle occupy the loams. It is necessary to have easily workable soils, for the dairy economy demands a greater variety of winter feed. The poor sand farms in many areas now produce a diversity of special crops, tobacco, fruits, canning crops, &c. As the pressure of population in this favourable area increases, agriculture will advance to meet the demands made upon it. This will involve further exploitation of the possibilities provided by the diversity of the soils. Agriculture does not advance by becoming independent of the environment, its security lies in a more wholehearted acceptance of its ecological controls.

PART V

THE NATURAL VEGETATION OF CANADA

Of all the maps which the geographer can construct of a large extent of undeveloped country the Vegetation Map offers the best guide as to how the region may be exploited for man's benefit. The natural vegetation is Nature's response to many of the same controls as those which affect man's well-being. The natural vegetation depends very greatly on the three fundamentals of temperature, rainfall, and soil. These have already been considered in some detail so that the vegetation map must agree in many particulars with various maps already charted. Many vegetation maps of North America have been published; but one of the latest and most comprehensive dealing with the Dominion, is that by W. E. D. Halliday in 1937.[1] It has been extensively used in the present general survey, and is the basis for Fig. 40.

The Canadian Archipelago, together with the lands on each side of Hudson Bay, form part of the *Tundra*. This belt extends from Alaska to Hamilton Inlet in Labrador; though luckily it is very narrow at the two extremities. By far the most extensive of the vegetation belts is the *Taiga* which covers more than half of the

[1] 'A Forest Classification for Canada', *Bulletin 89*, Forest Service, Ottawa, 1937.

Dominion. It is shown by diagonal ruling in Fig. 40. However, the most important areas, as far as settlement is concerned, are the smaller divisions along the southern and south-western margins, which have not yet been discussed. In the far south-east are the *Maritime* Belt and the *Lake* Deciduous Forest. In the west centre along the boundary is the small *Prairie* Belt; while in the mountain areas on the west are three subdivisions, all marked by Coniferous

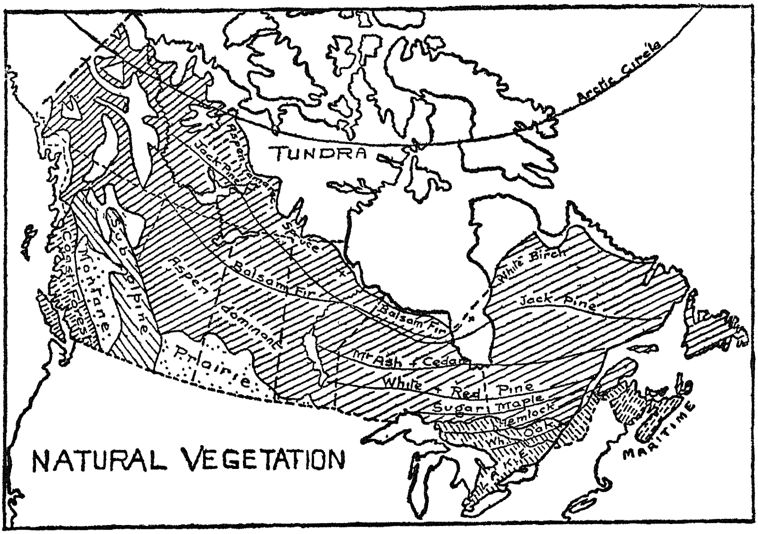


FIG. 40.—The natural vegetation of Canada. The treeless region (Tundra) is shown blank; the Boreal Conifer Forest (Taiga) is ruled; and the northern limits of the chief trees are shown by thin lines. (Based on W. E. D. Halliday and B. R. Morton.) (See also Fig. 87)

Forests like the Taiga, but containing different genera for the most part. The divisions shown are the *Subalpine* Belt, the *Montane* Belt and the West *Coast* Forest.

The Tundra or Barren Grounds

One of the most obvious of vegetation belts is that which extends north of the limit of trees. The northern edge of the Taiga is clearly marked on Fig. 41, but it will be well worth while to study the controls which have determined this very definite natural region. It is clearly not bounded by a circular isopleth about the North Pole as might have been expected; for the Tundra edge lies far south of the Circle in James Bay (lat. 54°), while near Alaska it is well north of the Circle in latitude 68°. It was pointed out earlier that this boundary in general was not far from the July isotherm of 50° F. (or 10° C.), but

this does not closely correspond to the vegetation, since if the winter is not too severe the summer may be relatively colder (i.e. well below 50° F.). For this reason M. Vahl has determined a simple formula which shows the effects of a less cold winter on this Tundra limit. Slightly modified the formula is as follows:

$$W = 9 - 0{\cdot}1\ C$$

In this formula W represents the average temperature of the *warmest*

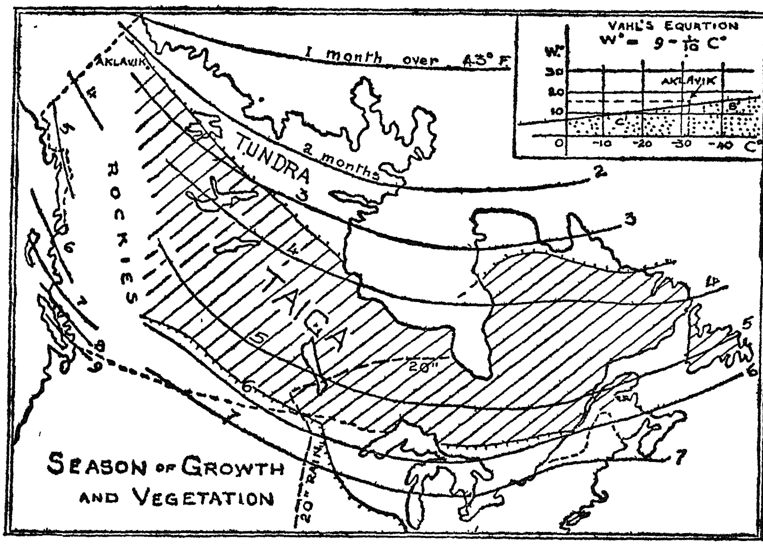


FIG. 41.—The map shows as isopleths the number of months in a year averaging over 43° F. This helps to determine the limits of the Taiga (shown ruled). Inset is a graph showing how Polar climates are defined)

month (usually July) expressed in degrees Centigrade; while C is a similar figure for the *coldest* month. This equation can be graphed as a straight line, and this is shown in the inset in Fig. 41.

Let us use the formula to see if Aklavik (at the mouth of the Mackenzie River) is actually within true Arctic climates. The temperature of the coldest month is − 32° C. Substituting in the above equation, we find that the temperature of the warmest month should be 12·2° C., if Aklavik fulfils the required conditions. Actually Aklavik is slightly warmer, i.e. 14° C. in the warmest month. Hence it is just too warm to be actually an Arctic climate. Its position on the graph is shown in the inset in Fig. 41. Two hypothetical places, B′ and C′, are shown on the graph which do fulfil the conditions. In the former January is − 40° C. while July is 15° C. In the case of C′ the two figures are − 14° and 10° respectively.

Limits of the Taiga

A very interesting problem is to determine the climatic controls which fix the southern edge of the great Coniferous Forest or *Taiga*. It can only be done approximately, and the chief data are charted in Fig. 41. Here isopleths show the *number of months* at a locality during which the temperature is above 43° F. (This is the temperature at which plant cells begin to grow rather readily.) In the map we see that in the Canadian Archipelago only *one* month rises above this temperature, but still many plants grow vigorously as we shall find later. The 'two-month' isopleth runs through the Polar hinterland, while the 'three-month' line agrees fairly well with the northern edge of the Taiga. The southern edge of this most important of the vegetation belts is seen to agree with the '5½-month' line in Canada. To the south the vegetation is quite different.

The factor which determines whether the warmer land shall carry a cover of grass or of deciduous trees is the rainfall. This is discussed by A. A. Miller (in his *Climatology*, London, 1931) in the following terms. The life cycle of grass makes it indifferent to prolonged drought, whose ill effects it escapes by seeding and dying down, to start life anew when the rains return. Its rainfall requirements are small, provided that the rain occurs over a period in which temperatures are sufficient for growth. The rainy season is usually in the spring or summer, as in the case of the Canadian Prairies.

The prolonged winter drought makes the interior of the warmer portions of the continents unfavourable for trees, which prefer *maritime* climates with their more regular moisture supply. In the *Broad-leaved Evergreen* trees (which hardly occur in Canada) growth is continuous throughout the year. Thus the temperature cannot fall below 43° F. in any month of the year, a condition not met in the Dominion. In the *Broad-leaved Deciduous* Forests there is a resting-period, at the beginning of which the tree sheds its leaves to grow a new leaf-cover as soon as conditions again become favourable. This type of Deciduous Forest needs adequate moisture, which in North America seems to be about an inch and a half during most months of the year. Thus the 20-inch isohyet approximately divides the prairie from the Deciduous Forest in the region of the Great Lakes (Fig. 41).

The Coniferous Forest (*Taiga*) also undergoes a long period of enforced inactivity imposed by the cold of winter. But by the survival of the leaves through this resting period, the coniferous tree is ready to begin assimilating without delay as soon as temperatures become favourable. Often the conifers pollinate in one year, and disperse the pollen in the next year; whereas the deciduous tree has to pass through the whole process in one year. There is

seen to be a rather close relation between the isopleths plotted on Fig. 41 and the northern boundary of the Deciduous Forest. In the region with adequate moisture (i.e. the east) the critical isopleth seems to be about $5\frac{1}{2}$ months of a growing season, as mentioned earlier.

However, these present climatic controls are not the sole factors; since forests take a long period, possibly centuries, to respond to changing climatic conditions. This concept has been studied in considerable detail by Clements and Chaney in their memoir *Environment and Life in the Great Plains* (Washington, 1937). They make it clear that the boundaries of the Prairies and the forest are still fluctuating. Indeed, it is not many millennia since the tundra and prairie were probably in contact, though today the Taiga forms a very broad belt separating these vegetation types. The common trees of the Taiga are indicated in Fig. 42.

The belt of *Deciduous Forest* in the south-east corner of the Dominion is small compared with the two previously considered belts. But it contains some of the best farmland, and the older settlements. Here we find Sugar Maple as one of the northern deciduous trees, while the habitat of the Mountain Ash or Rowan (*Sorbus*) also reaches far into the Taiga, as is clear from the line on Fig. 40. Yellow Birch, Black Ash (*Fraxinus*), and White Oak, are also found, mixed in larger proportions with the pines and spruces of the Taiga, as we proceed north across the boundary indicated in Fig. 40. A small subdivision along the north shore of Lake Erie is named the *Niagara Forest Belt* by Halliday. It contains the same genera as are characteristic of the Ohio forests to the south, such as Magnolia, Papaw, Redbud, Sassafras, Chestnut, Hickory, &c.; but it is too small a division to be shown on the general map given in Fig. 40.

In the *Maritime* districts of the Dominion a transition type of forest is found, which Halliday describes in the following terms. It contains some of the same conifers as are found in the Lakes division to the west. Among these are the Hemlock, and the Red and White Pines; but the characteristic tree is the Red Spruce (*Picea rubra*), which does not extend much beyond the Maritimes. This belt also includes many of the northern 'hardwoods', such as sugar maple, yellow birch, and beech; while it is allied to the Boreal Forests (or Taiga) by the abundance of White Spruce and Balsam Fir (*Abies balsamea*).

Turning now to the Pacific coasts, the heavy rainfall, warmer temperatures and mountain topography have produced a forest cover quite different from that in the centre or east of the Dominion, except perhaps in the *Subalpine* section which links the Pacific Forests to the Taiga. The White and Black Spruces are found to extend from

the Prairies well into British Columbia, while the Lodgepole Pine (*Pinus contorta*) has spread from the west well into the Prairies. But the characteristic tree of the Subalpine Forest is the Engelmann Spruce (*Picea Engelmanni*). The Hemlocks (*Tsuga*) are common to the Subalpine Forest and the Coast Forest, though they grow to greater heights in the coastlands (Fig. 113).

The *Montane* Forest is a very interesting subdivision, which spreads through the rather dry elevated basin in the interior of British Columbia. The dominant trees are Yellow Pine (*Pinus ponderosa*) and Douglas Fir (*Pseudotsuga taxifolia*). Lodgepole pine and aspens are also abundant. In the lower portions of the valleys the rainfall is so low that forests are replaced by strips of semi-arid grassland with an abundant cactus flora.

The *Coast* Forest contains the finest trees in Canada, and considerable areas in the north and in the Queen Charlotte Islands are still unexploited. The dominant trees are the Western Red Cedar (*Thuja plicata*) and the Western Hemlock (*Tsuga heterophylla*). The Douglas Fir is common in the southern portions of this forest, while the Sitka Spruce (*Picea sitchensis*) becomes more abundant in the northern areas.

In the north of British Columbia and in the Yukon region there are considerable mountain regions which are too cold for forest cover. These are left blank in the map (Fig. 40), though they do not carry a cover of the tundra plants of the same kind as in the plains to the east.

There remains one important vegetation belt which contains few trees. This is the Canadian *Prairie* (Fig. 40), which can be described in three sections. Bordering the Taiga on the north of the Prairie is the '*Park Belt*', which has an annual rainfall of about 15 inches. The common vegetation cover consists of the *tall* prairie grasses, such as the wheat grasses, reed grasses, June grass, &c. These grassland areas are dotted with 'bluffs' which are small patches of woodland, largely aspens or allied poplars. To the south is the '*True Prairie*' where the rainfall varies from 15 inches down to 11 inches near Medicine Hat. The *short* prairie grasses, such as Blue grama and spear grass are characteristic. In the driest *Semi-Desert* portion true desert plants like Sage Brush (*Artemisia*) and various forms of cactus are quite common plants. These three belts in the Prairies agree fairly well with the types of agriculture practised there. The northern 'Park Belt' is devoted to Mixed Farming, the central belt is almost wholly used for wheat, while the arid southern region is naturally best suited for grazing (Fig. 60).

The Canadian Conifers

Most readers of this book will have a fairly clear idea of the main

characteristics of the broad-leaf deciduous trees, such as the oaks, elms, poplars (including the aspens and cottonwoods), maples, birches, and willows. But the conifers are much more abundant in Canada, and in the lumber and pulp industries much more important;

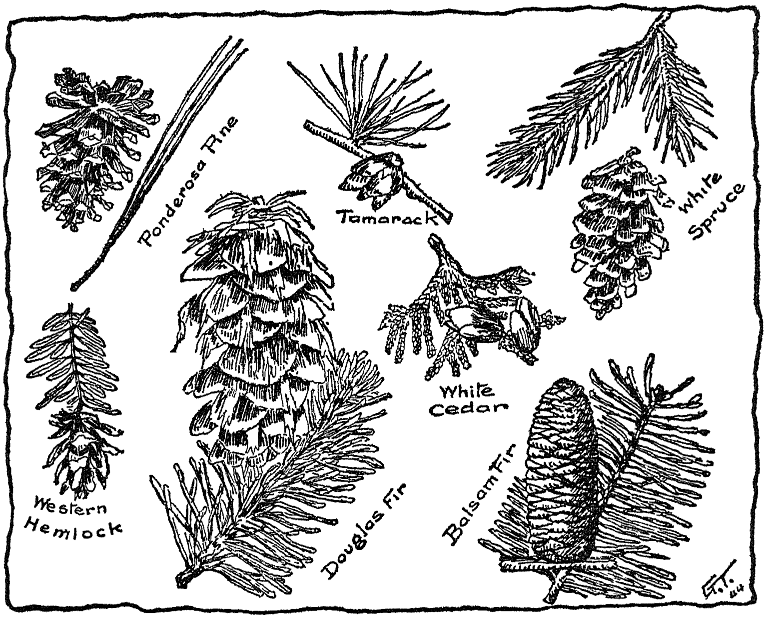


FIG. 42.—Sketches of the leaves and cones of seven dominant conifers

so that their chief distinguishing features—as given in the table on page 110—will be of interest. Some of the commoner types have been sketched (in Fig. 42), from the drawings given by B. R. Morton in his pamphlet *Native Trees*. In the sketches notice the *bundles* of needles in the foliage of the pines and tamaracks. The composite leaves of the hemlocks and firs are *flat*, while in the spruces the leaflets are arranged irregularly round the main stem. In the hemlocks the cones hang down, but in the balsam fir they stand erect. For further details the pamphlet by B. R. Morton (published in Ottawa in 1939) should be consulted.

Name	Species	Height (feet)
Pines (*Pinus*)		Up to 175
White P.	*Strobus*	100
Red Pine	*resinosa*	*do.*
Jack P.	*Banksiana*	80
Yellow P.	*ponderosa*	160
Lodgepole	*contorta*	80
Spruces (*Picea*)		
Black S.	*mariana*	35
White S.	*glauca*	50–100
Red S.	*rubra*	50
Engelmann	*Engelmanni*	80–180
Sitka	*Sitchensis*	125–250
Hemlocks (*Tsuga*)		
Eastern H.	*canadensis*	60
Western H.	*heterophylla*	130
Cedar (*Thuja*)		(Bark shreds)
White C.	*occidentalis*	45–50
Red C.	*plicata*	150–175
Fir (*Abies*)		
Balsam	*balsamea*	50
Douglas Fir (*Pseudotsuga*)		150–300
Tamarack (*Larix*)		60

Leaf form	Cone form	Habitat
Needles	Thin or woody scales	
Bundles 3–5	Slender 5–10 in. Thin scales	Throughout SE. (Fig. 42)
Bundles of 2	Spherical 2 in. woody	*do.*
Short, in pairs	1½ in. in pairs, persist	All taiga
Long, in threes	2–5 in. (see Fig. 42)	South B.C.
Short, in pairs	1–2 in. prickly, persist	All B.C.
Pointed, quadrate and crowded on twig		
½ in. long	1 in. spherical, persist	Throughout
¾ in. (grey bark)	1½ in. elastic scales drop off	Throughout
½ in. (red bark)	1½–2 in. oblong, drop	Montreal to E.
1 in., bluish	1–3 in. scales papery	Inland B.C.
Thick	2–4 in. *do.*	Coast of B.C.
Flat, two-ranked with tiny stalks		
½ in., green, white below	¾ in., hang down	Soo to Sydney
do.	1 in. red, few scales	Wetter B.C.
Tiny scales	Tiny cone	
Rows of shingles	½ in., twelve scales	Winnipeg to Fundy
Flat sprays	½ in., six scales	Southern B.C.
Flat, two-ranked	Erect, cores persist	
¾ in., shiny top	2–4 in.	See Fig. 40
Flat, two-ranked	2–4, hang down, bracts	South B.C.
Brush of needles, deciduous	Small and stalked	All except B.C.

PART II

THE NATURAL REGIONS AND THEIR VARIED ENVIRONMENTS

CHAPTER VI

NATURAL REGIONS OF CANADA: THE EASTERN SETTLEMENTS

IN every large area, such as that of the Dominion of Canada, which totals some 3½ million square miles, there are bound to be great diversities in the climate, landscape, and other features of geographic significance. It is obvious that one of the first problems in our detailed discussion will be concerned with the breaking down of this huge area into manageable units. These units should of course be as homogeneous as possible; but we cannot expect too great uniformity, since no valley or hill is just like its neighbour.

The experience of the writer in regard to an analogous case—that of Australia—has led him to the conclusion that a total of about twenty such units is advisable. Such geographic units, each of which exhibits a useful degree of homogeneity, are often called *Natural Regions*. From the discussion in the previous chapter it should be evident that the natural vegetation map gives us much help as to where we should draw our major boundaries for the natural regions. At the same time topography and climate must be considered independently of the vegetation, and since our problem is considerably affected by the type of people who dwell in the specific regions, we must consider the human aspect somewhat also. In fact, any attempt to subdivide Canada into twenty natural regions is bound to be somewhat of a compromise; and it is unlikely that any two authors would agree as to the subdivisions to be chosen.

The primary criterion that the writer prefers to use is that of topography. There are five major topographic units in Canada, differing greatly in extent, as well as in their essential geological structure. These are the Young Mountains of the west; the broad Prairies and the Mackenzie valley, mostly in the Geo-syncline; the Great Canadian Shield; the younger areas which border the Shield on the south-east, which may be associated as the Great Lakes and Maritime area; finally, in the far north, is that large cluster of islands (known as the Canadian Archipelago) which have many elements of climate and structure in common, and may be said to constitute the fifth and last topographic division. Politically this is known as Franklin.

Each of these five major divisions will be divided into smaller subdivisions, depending partly on the respective areas. But the human factor comes in here quite importantly. If the human

response to the environmental conditions is considerable, then population becomes denser, and it may be advisable to have more subdivisions than in an area where there is a very sparse population. Furthermore, it is advantageous to link those areas which have been developed early in Canada's history, and consider them first. Of course, in general this means that the best-endowed portions of the Dominion are those first described.

The twenty subdivisions chosen by the writer, together with their dominant characteristics (Fig. 43), are classified in the following

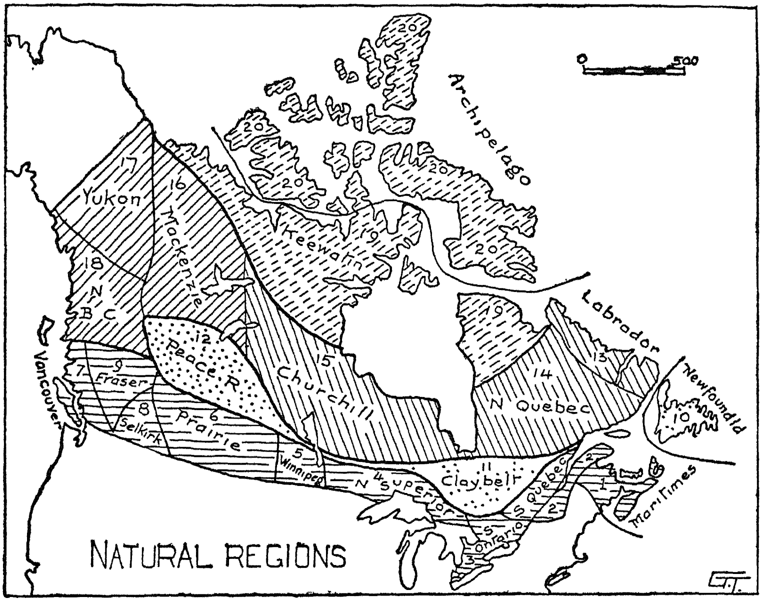


FIG. 43.—Canada divided into twenty Natural Regions—arranged in four zones from south to north: i.e. Populous; Transition (dotted); Pioneer; and Tundra (dashes). See Endpaper Map for further details

table. The topographic characters are shown by the vertical columns, while the settlement characters are suggested by the horizontal grouping. Along the southern margin is the '*Populous* Zone', which includes the nine 'natural regions' where there is a fairly dense population. Next come three areas where population is important, though not dense; and this I term the '*Transition* Zone'. To the north are six '*Pioneer* Regions', divided into eastern and western sections. The empty '*Tundra* Zone' contains the last two of the twenty natural regions. This classification explains the order of the chapters followed in Part II of this volume.

TWENTY NATURAL REGIONS OF CANADA (Fig. 43)

	Western Mountains	Central Downfold	Eastern Shield and its borders
A	*Populous Zone* 7. Vancouver 8. Selkirks 9. Fraser	5. Winnipeg 6. Western Prairie	1. Maritimes 2. South Quebec 3. South Ontario 4. North of Superior
B	*Transition Zone*	12. Peace River	10. Newfoundland 11. Claybelt
C	*Pioneer Zone* 17. Yukon 18. North British Columbia	16. Mackenzie	13. Labrador 14. North Quebec 15. Churchill
D	*Tundra Zone*		19. Keewatin 20. Archipelago

NATURAL REGION I: THE MARITIMES

It is logical to commence our study of the regions of Canada in the extreme east of the continent, where the first important settlement occurred. The Maritime Provinces of Nova Scotia, New Brunswick, and Prince Edward Island are famous in the history of the Dominion; but their small size, somewhat rugged topography, and rather cool marine climate have resulted in their lagging behind other later settled portions of the continent, which have been better endowed in climate, soil, and topography.

The general structure of the three provinces has been referred to in the earlier chapter on topography (p. 47). The details are fairly clearly represented in the mantle-map given as Fig. 44; and in the geological section across Region I (given at the foot of Fig. 44), which shows that the Maritimes consist essentially of a shallow geological Basin or syncline, whose asymmetric centre has been drowned to form the Bay of Fundy. The long axis of the syncline runs south-west–north-east along the bay, and is bordered on each side by the high rims of the basin. These culminate in the Shick-shock Mountains of Gaspé on the west, and in the much more moderate heights of Nova Scotia and Cape Breton Isle in the east.

Right through geological history the earth folds in this area have had much the same general direction.[1] This is due to long-continued

[1] Good illustrations of geological features in New Brunswick are given by F. J. Alcock in *Canad. Geog. Jnl.*, August 1943.

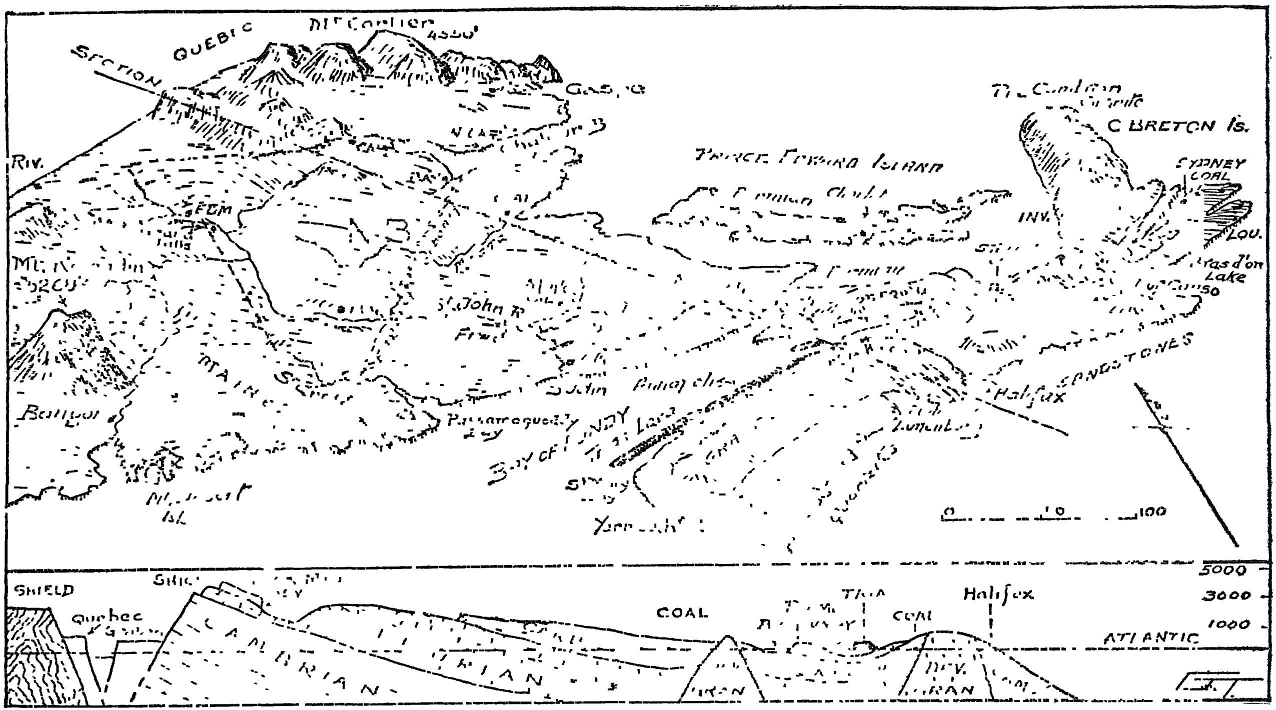


FIG. 44.—A sketch of a model of the Maritimes, illustrating structure and geology. The scale in the main map is only approximate. (Below is a geological section along the line indicated)

compression between the Canadian Shield to the west and the vanished land mass of 'Appalachia' to the east. The estuary of the St. Lawrence, the boundaries of the Champlain Sea, the strike of the Paleozoic beds of southern Quebec, &c., are all determined in large part by this dominant series of folds in the Maritimes. The structure of the basin is complicated by the presence of hard inliers of Devonian granite which rise above the central portions of the basin in the form of the Cobequid Hills and Caledonia Hills to the south-west of Moncton.

The influence of the structure upon settlement is fairly well pronounced in the Maritimes. The two general principles are illustrated in this region; firstly, that the metallic minerals are associated with the older rocks; and secondly, that the best agricultural lands on the whole are based upon the newer rocks. However, here as elsewhere the presence of large rivers with their accompanying flood silts complicates the pattern. The sole metals of note occur in the older Pre-Cambrian rocks and associated eruptives of eastern Nova Scotia. These are shown fairly well at the right-hand side of the section in Fig. 44. There does not appear to be much mineralization of the corresponding Cambrian formations along the Gulf of St. Lawrence, probably because there are few eruptive rocks in that district.

Lying above the Cambrian is a widespread series of old Paleozoics, mostly of Silurian age. This series of sandstones, &c., gives rise to poor soils, and the map on page 496 shows that there is no important settlement on this formation, save where the River St. John has laid down a good deal of river silt upon the Silurian deposits. Above this formation there are widespread Carboniferous strata, whose western edge is emphasized in the map (Fig. 44). These also give rise to somewhat sterile soils, but in places there are restricted areas of coal, especially near Minto, Joggins, Stellarton, and Sydney. Between the Carboniferous and Silurian areas there is an extensive batholith of granite.

One of the most useful series is the Permian, lying above the Carboniferous and occupying a good deal of the centre of the geological basin. As reference to the section (Fig. 44) will show, these soft red sandstones lie at the head of the Bay of Fundy, and also build up most of Prince Edward Island. In Triassic times there was a good deal of volcanic activity, and flat sills of basic lava poured out above the older formations. The upturned edge of these sills forms the hard barrier of rock which borders the east coast of the Bay of Fundy. The softer Triassic sediments beneath it have been eroded to form the famous Cornwallis valley, whose southern portion is drowned by the sea, forming St. Mary's Bay.

The general topography for the most part is hilly rather than

mountainous, for heights over 3,000 feet are only found in Gaspé, which is part of Quebec. A few points in northern New Brunswick exceed 2,000 feet, and the cliffs around the north end of Cape Breton Isle border fairly high plateau-like hills. There is obviously no room for long rivers in this region of islands and peninsulas, and St. John and Miramachi (Mìrama-chèe) are the largest and are shown on the map. The remarkable tides of the Bay of Fundy, due partly to the funnel shape of the body of water, are well known. At times the water rises as much as 60 feet at the head of the Bay.

Climate and Vegetation

The climate of the Maritimes is a mixture of continental and marine conditions.[1] Since the general drift of the air, and of the dominating cyclones, is from west to east, a good deal of the weather agrees closely with that of the continental portions of the land to the west. But the Atlantic Ocean bathes the deeply indented coasts, and exercises an ameliorating influence. Thus the interior of New Brunswick shows a range of temperature of about 33 degrees, while at Yarmouth on the south coast of Nova Scotia the range is only 20 degrees. Fredericton, the capital of New Brunswick, varies in temperature from 66° F. in July to 13° F. in January. Halifax in Nova Scotia has a much less range, between 65° F. and 23° F. in the same months. The rainfall is satisfactory throughout, with the highest figures on the coast (60 inches) near Halifax. The uplands of New Brunswick receive about 40 inches, but there is an interesting 'rain shadow' at the head of the Bay of Fundy where the rain is distinctly less. The rainfall is fairly uniform, though there is a maximum in the winter months, except in the St. John valley. Here the inland areas tend to have a summer maximum. Fogs are rather frequent on the coast; especially in the early summer, when warm moist air blows over the chilly coastal waters. Yarmouth is noted for fogs (p. 211). The snowfall varies a good deal from year to year, but may amount to 100 inches in inland districts (Fig. 45).

The peculiar climate of the Maritimes, where so many of the storm-producing cyclones move out from the Continent, is hardly paralleled in other parts of the world. Here also two of the most striking ocean currents come into conflict, the so-called Gulf Stream from the south and the cold Polar current from the north. The winter isotherms are closely 'packed' in this part of North America for this reason. Probably only in the vicinity of the northern island of Japan (Sapporo in Hokkaido) is there a region which can be called a homoclime. Köppen places the Maritimes on the edge of his Dfb climates. As a result of the rather cool summers the staple

[1] For a fine series of maps illustrating the climate of the Maritimes, see the article by D. F. Putnam in *Canad. Geog. Jnl.* for September 1940.

crops are hay, oats, and potatoes. Their distribution is discussed in detail in a later chapter.

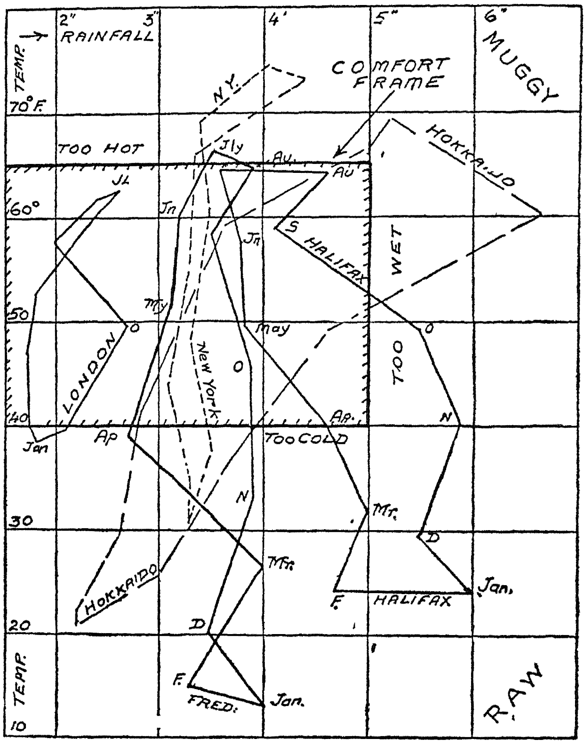


FIG. 45.—Hythergraphs (giving monthly temperatures and rain) for Halifax, Fredericton, London (U.K.), and Hokkaido (Japan). The rectangular 'Comfort Frame' is added

In Fig. 45 a somewhat new method of charting the climates of a region is attempted. It enables the reader to get the accurate monthly data of a given place, as far as temperature and rainfall are concerned. But it also enables him to compare such climates with those of places more familiar to himself, and it also shows with some accuracy the characteristics of the climate of the most similar foreign locality. These distant similar climates were named *homoclimes* by the writer in 1915. In regard to the Maritimes, two hythergraphs are charted (see Fig. 47 for other hythergraphs). The graph for Halifax is of the *marine* type. Its position, mainly in the lower right corner of the graph, shows that it has on the whole a rather 'raw' climate during the cooler months of the year. The rainfall is fairly uniform, but there is a definite winter maximum. The

graph for Fredericton exhibits an almost uniform rainfall—as shown by the long axis being vertical. The climate is more *continental* than that of Halifax, due primarily to the much colder winter. In midsummer the conditions are the same in the two towns.

New York has much the same climate as Fredericton for about seven months, but is much warmer in summer. London, England, is much drier than either, and has a much more equable climate. In trying to deduce homoclimes, the range of temperature is one of the chief criteria; but no foreign place seems to agree very well. Hokkaido is given by Köppen as a similar *coastal* variety of the Dfb type of climate. Its graph is given in Fig. 45, but the summer maximum is not found in the rainfall of most of the Maritimes.

The question of a *comfortable* climate is one which is becoming of more and more interest; and the heavy rectangular frame in Fig. 45 is inserted to enable this problem to be studied. I have chosen the temperatures of 65° F. and 40° F. rather arbitrarily as limiting comfortable temperature conditions. If a place receives more than 5 inches of rain a month I have classed it as 'too wet'. Accepting these conditions, it is seen that London has a comfortable climate, except in midwinter. New York is both too hot in summer, and too cold in winter. Most folk, as mentioned, would find the Maritimes too cool and wet in winter, as is shown by the graphs extending far beyond the 'comfort frame'.

The forests of the Dominion have been discussed in the excellent Bulletin by W. E. D. Halliday to which reference has already been made. Halliday makes a distinct subdivision of the forests in the Maritimes to which he gives the name Acadian Forest Region. The forest partakes of the characters of the trees in the surrounding areas, and like many adjacent areas this region suffered great changes during the Ice Ages. The white spruce, balsam fir, aspen, and white birch migrated into the region at that time, and many of the warmth-loving trees were no doubt killed off. But butternut, maple, and oak still survive in many areas.

In the upland interior portions of New Brunswick, balsam fir and black spruce are perhaps the commonest trees. White and red pine have largely been removed in lumbering operations. On the better soils, birch, beech, maple, and hemlock are somewhat more abundant than on the uplands. Along the east coast of New Brunswick the soil is poorly drained, and cedar and tamarack are very abundant. Red spruce, so-called from the colour of the bark, is found only in the Maritimes and adjacent parts of Quebec. The better soils of the St. John valley and of Prince Edward Island have led to a considerable development of trees like the butternut and basswood, while red oak, maple, and beech are common. Of course, conifers like white and black spruce are to be found in all sections also.

On the Atlantic slopes of the Maritimes red spruce and balsam fir are dominant on the lower and upper slopes respectively. There are large areas of barrens and open bogs. Balsam fir is even more abundant in the forest of Cape Breton Island, which is notable for the rarity of white pine and hemlock as compared with the southern districts. (For crops, &c., see later chapters.)

Cape Breton Island

Cape Breton Island is separated from the main portion of the Province of Nova Scotia by the narrow Strait of Canso.[1] This is crossed by large ferries which carry the trains to the island and ultimately to the port of Sydney, 'the eastern wharf of Canada'. The island is a little over 100 miles long and rather less in width. It is unique because such a large portion of the island is occupied by the broad arm of the sea called Bras d'Or. This is of course merely a drowned portion of one of the major valleys between the dominant folds already discussed. But the outlets to the sea are quite narrow in the north, while a short canal has been cut near St. Peter's to link the marine lake to the Atlantic.

As will be seen from the map (Fig. 44), the structure gives the key to the settlement and industries of Cape Breton. In the north is a bold plateau rising to 1,800 feet which is practically unoccupied. The scenery along the coasts is unusually attractive, but roads are almost lacking in the north. Two areas of coal measures fringe the north-east and south-west coasts, and these have led to mining towns. Inverness on the west coast is not important, but Sydney on the north-east coast is one of the chief industrial cities in Canada. Some account of the coal-mines and of the large steel industry—based on iron ore from Newfoundland—will be found in a later chapter. The population is clustered chiefly around these two centres, with many small farms in the lowlands around the Bras d'Or. There are rather marked cultural divisions in the small island since the centre and east coast is predominantly Scottish. Indeed, it is stated that the ancient Gaelic tongue is better preserved here than in Scotland itself. Skir Dhu, Claverhouse, and Loch Lomond are some of the many Scottish names in this part of Canada. In the south-east near the Strait of Canso, as in the north-west, there is a dominant population of folk of French culture, while many Irish have helped to develop the coal-mines in the vicinity of Sydney. The coastal waters, including those of the Bras d'Or, contain abundant fish, while the scenery attracts many tourists. Probably the most interesting district is that surrounding the old fortress of Louisburg. This was captured from the French in 1745. Glace Bay is the centre of the chief coal-mines near Sydney. Port Hawkesbury is a small town where the railway ferry reaches Cape Breton Island.

[1] A Causeway now crosses the strait.

Peninsular Nova Scotia

This southern portion of the province is conveniently divided into two parts by a line joining Windsor to the Strait of Canso. As the map in Fig. 44 shows, the more northern of these two areas consists essentially of younger sediments, Carboniferous to Triassic; while the southern portion is largely granite or Pre-Cambrian sediments. It is easy to deduce how the settlement has progressed in the two areas. Apart from the large town of Halifax, based on the excellent harbour and on the political importance of the capital, there is no major centre in the southern section. Indeed, the agriculture is of little importance, and the numerous coastal villages are dependent primarily on the rich fisheries which lie off eastern Nova Scotia.

The gradual slope from the granite divide in southern Nova Scotia to the Atlantic Ocean seems to be part of a former level peneplain, which cuts across most of the ancient formations.[1] It has, however, been tilted down to the south-east, but the softer layers in the rocks have been somewhat eroded below the general surface of the peneplain. These ancient rocks consist of quartzites and slates, which have been folded into anticlines and synclines in a somewhat complicated fashion. In the domes of some of these anticlines, especially in the district between Halifax and Truro, there are numerous quartz veins, which have been found to contain payable gold. The soils are rather sterile and there is not much agriculture, except perhaps in the vicinity of Lunenburg. The latter is chiefly associated with dairy-farming to supply the adjacent naval base and capital of Halifax. (See maps, p. 386.)

Halifax is the largest of the Maritime cities, with a population of about 70,000. It is situated in an extensive depression on the east coast, whose topography has been much modified by the deposition of glacial debris in the form of oval drumlins. The narrow harbour, extending from the ocean to Bedford, is about 12 miles long, and it has been strongly fortified since the early days of British settlement. It is the Atlantic terminus of the Canadian National Railways, and is the chief winter port of the Dominion, when almost all the other ports are hemmed by bay ice. Lunenburg and Yarmouth are small fishing towns to the south (Plate 1).

A sort of transition area lies along the eastern side of the Bay of Fundy. Its remarkable structure is clearly sketched in Fig. 44. Between the ancient rocks of the main peninsula and the long narrow ridge of Triassic lavas ('North Mountain') already described, there is a well-marked depression occupied by the Cornwallis River, the

[1] One of the best topographic studies of any part of the Dominion is J. W. Goldthwait's 'Physiography of Nova Scotia', *Geol. Survey Memoir 140*, Ottawa, 1924.

bay south of Annapolis and St. Mary's Bay (inset section; Fig. 44). This depression is eroded in Triassic rocks, which are relatively fertile and contain some of the most productive apple orchards in the Dominion. The sheltered character of the bay near Annapolis, entered by a breach in the lava rampart, is quite obvious, and directly led to the earliest European settlement in this part of the Dominion. Annapolis was founded as early as 1604 by the French, who gave it the name of Port Royal.

The pattern of the remaining north-west part of Nova Scotia is somewhat complicated by the presence of the sterile granites of the Cobequid Hills. Fertile Paleozoic and Triassic soils surround this elevation, and have long been occupied as farmlands. Much of the flat coastland is laid bare at low tide, and has gradually been reclaimed by strong dykes. Coal towns are present in the north, such as Joggins, Spring Hill, Stellarton, Pictou, and New Glasgow. Truro, Windsor, and Amherst are prosperous railway and farming centres.

Prince Edward Island

This small province has an area of little over 2,000 square miles yet its agricultural importance (based on half a million acres of croplands) is not far from that of British Columbia with an area of 366,000 square miles. Hence it is the most densely populated of the provinces, the density rising to 43·5 per square mile. The island is crescent-shaped, and is about 150 miles long. Very little of it rises to 500 feet, and it consists of a rolling topography intersected by wide valleys. These are drowned by the sea to form rias, and there is less than 2 miles separating the headwaters of two of these drowned valleys (on opposite coasts) in the vicinity of Charlottetown. As stated, the rocks consist very largely of fairly level Permian sandstones and shales. In general, the northern coasts are marked by long sandy beaches, while the southern shores exhibit rather low sandstone bluffs.

The absence of topographic obstacles, and the abundant fertile soils led to the early occupation of the Island. The population reached 109,000 in 1881; but has been stagnant or diminishing since that date. It is now about 98,429. This decline is due to the superior attraction of the new lands in the Prairie provinces, and to the absence of coal- or water-power which might support industrial developments. The breeding of silver foxes in captivity is almost the sole change of note in the economy of the province in recent years.

There is only one town of note, Charlottetown the capital.[1] It

[1] For a study of this very interesting capital, with two maps, see the writer's article on 'Town Patterns on the Gulf of St. Lawrence', *Canad. Geog. Jnl.*, June 1945.

has a population of about 16,700, and has grown very little in the last half-century. The town lies on a low promontory projecting from the north into the ria of Hillsborough Bay. It was laid out in the usual gridiron plan about 1770, and still preserves the four small parks of the original plan. Summerside to the west and Souris and Georgetown to the east are small seaside towns with interests in fishing, farming, and tourists (Fig. 122).

New Brunswick

This province is the largest of the three comprising the Maritimes, and covers 27,473 square miles, as compared with 20,743 for Nova Scotia. It may well be divided into three districts, which, as usual, are based upon the structure. Nearly all the area in the centre and north, extending between Quebec province and Moncton, consists of the rather sterile Paleozoic formations; and is almost devoid of settlement, except along the Miramachi valley. The valley of the main river, the St. John, forms the second division, and occupies the western fringe of the province. The south-east quarter is the last of these districts, and contains valuable coal, as well as good agricultural lands (Fig. 44).

Throughout the north and centre there are large areas of woods, in which however the best pine has long been exploited. There are small pulp-mills based on these forests, but they are chiefly found on the margins of the forests in the other two districts. However, forestry is the most important occupation in New Brunswick, and an account of the timber trees has been given already. In recent years small settlements, such as Hazen and Grimmer, have been opened in the forests, chiefly north of the Miramachi valley. In the latter are small towns such as Blackville and Doaktown.

The St. John River forms part of the western boundary of the province. Its northern portion runs in an incised canyon in places, and at Grand Falls a good deal of power is available. But south of this point the valley broadens, and extensive agricultural areas are available. The richest farmlands in the province lie between Grand Falls and Fredericton, and here is situated one of the chief potato-producing districts in Canada.

Fredericton, the capital, is a very small city with a population of 18,000. Small steamers reach it from St. John on the coast. There is some manufacturing, utilizing the timber and leather grown in the vicinity. The lower valley of the St. John is marked by the presence of large linear lakes, and its outlet at the port exhibits a unique feature. Owing to a ridge of hard rock crossing the river, and to the remarkably high tides along the coast, the phenomenon of 'reversing falls' occurs at St. John. At low tides there is a normal fall from the river into the sea; but at specially high tides there is

a fall of salt water of about 10 feet into the river, here constricted into a rocky gorge only 400 feet wide.

Saint John is by far the largest city in the province, though it did not become the capital in 1785 owing to its accessibility to foreign naval attack. The population is about 52,000; and the city extends on both sides of the mouth of the river, though the chief area is on the promontory to the east. St. John is a prominent Canadian seaport, especially in winter, and is a terminus of important railway lines. It is the site of numerous small factories, in part due to the considerable lumbering and fishing industries. Others are connected with the construction of railway and steamship material. Its palmy days of building wooden ships are now over.

In the south-east and eastern portions of the province are many small towns based primarily on fishing and coal-mining. In the south-east corner between Moncton and Sackville is a flourishing agricultural area, the chief crops being hay, oats, and potatoes. Between St. John and Moncton lies the chief dairy district of New Brunswick. Some coal is mined near Minto, but the annual production of half a million tons is only one-fifteenth of that of Nova Scotia. A little petroleum is obtained in the vicinity of Moncton. Along the eastern coast of the province from Moncton to Campbelltown (CAM. in Fig. 44), and indeed west to Edmundston, the population is almost wholly French. Fishing is an important occupation, but crops of the kind already specified also engage the attention of the French inhabitants. Newcastle and Chatham at the mouth of the Miramachi are however largely settled by Scottish folk (Fig. 122).

NATURAL REGION 2: SOUTHERN QUEBEC

The key to the settlement of southern Quebec is very definitely linked with the structure. Although the total extent of the Province of Quebec is 523,000 square miles, only about 9,500 square miles are used for agriculture. Although there is a good deal of mining outside of the farming area, these figures show us that most of this large province remains much as it was before any Europeans arrived.

In Fig. 46 this is shown rather clearly in the inset map. It is seen that the notable population is confined to the immediate vicinity of the St. Lawrence estuary; the sole extensions being along the Saguenay and Ottawa valleys. If we now turn to the main map in Fig. 46 we see that the ancient rocks of the Laurentian or Canadian Shield are almost devoid of settlement; while the rugged ranges of the Appalachians to the south are almost equally unsatisfactory for human occupation.

The more attractive portion of southern Quebec consists essentially of a long narrow strip of territory which was occupied by the

sea during late glacial times. This area is shown by dots in Fig. 46. This sea has been given the name ‘ Champlain Sea ’, and only vanished as the land slowly rose after the lightening of the ice load on the crust gradually began to take effect.

Under the marine sediments laid down by the Champlain Sea there are Paleozoic formations which have repeatedly been affected by pronounced south-west to north-east earth-folds. We may believe that early fold-mountains (akin to the Appalachians) occupied this weak portion of the earth's crust, though most of the mountain mass has vanished through erosion. The front edge of this markedly

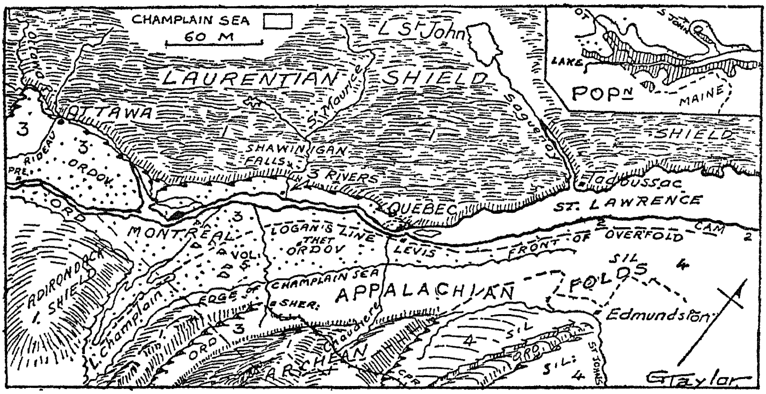


FIG. 46.—Structure of the St. Lawrence basin between Gaspé and Ottawa. The former depressed area known as the ‘ Champlain Sea ’ is dotted. Prescott and Sherbrooke are indicated by initials

folded area is indicated in Fig. 46 by the label ‘ Logan's Line ’. There seems to have been some faulting also, which has brought the older rocks of the Shield to a greater elevation than the younger (Paleozoic) sediments, all along the line from Quebec to Ottawa (Fig. 46). In Eocene (?) times there was a line of volcanoes extending east of the site of Montreal. The plugs of these volcanoes stand up today as the Monteregian Hills, and indeed Montreal itself is built on the slopes of the volcanic plug called Mt. Royal.

There is, however, one region of southern Quebec, lying well to the east of Tadoussac in Fig. 46, which is not charted in the latter map. To learn its structure we must turn to Fig. 44, where it appears as the mountainous district to the east of Rivière du Loup (RIV.). This ends in the district of Gaspé Peninsula, and the whole region east of Rivière du Loup is often loosely referred to as Gaspé (Fig. 49). It is of course the eastern extremity of the Appalachian fold-mountains, which were peneplained and then elevated more or

less *en masse* during the last major period of earth movement. Hence the summits of the Shickshock Mountains, such as Mt. Cartier (4,350 feet) are plateau-like rather than rugged in their character. Geologically these mountains are built up of Paleozoic sediments, whose structure is fairly well indicated in the section below Fig. 44. The north coast of the Shickshocks is almost precipitous, rising steeply from the sea in places, and is much visited by tourists for its romantic scenery. The southern shore of Gaspé is low and uninteresting, and the rise from such places as New Carlisle (Fig. 49) to the summit of the northern plateau is rather gradual.

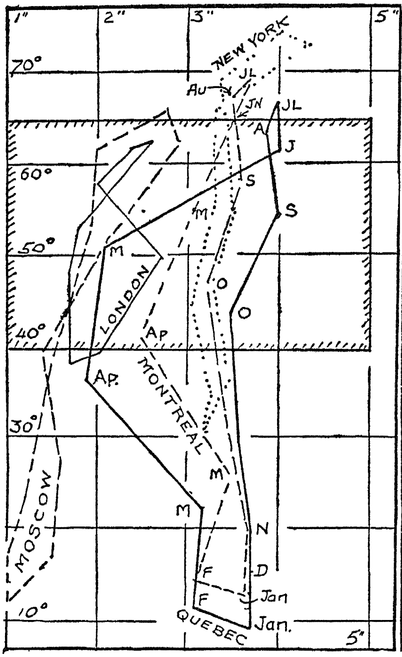


FIG. 47.—Hythergraphs for Quebec, Montreal, New York, London, and Moscow

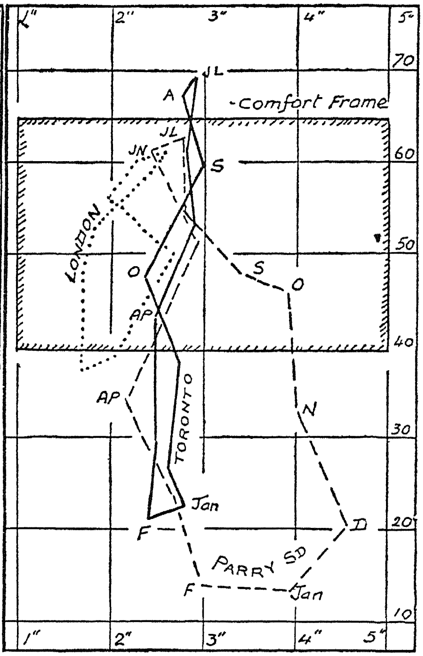


FIG. 48. — Hythergraphs for Toronto, Parry Sound, and London (U.K.)

Climate of Southern Quebec

As we move into the interior of the Dominion the climate naturally becomes more continental, and on the average the range of temperature along the St. Lawrence is about 58° F. It is worth noting that this range falls off in southern Ontario and is 10° F. lower at Toronto. At Quebec the range is from 9·7° F. in January to 66·7° F. in July; while at Montreal the corresponding figures

are 13° F. and 69·5° F. Reference to the graphs in Figs. 47 and 48 show that the rainfall at these two chief centres is almost uniform, though there is somewhat of a minimum in spring. Some of the heaviest snowfalls in the Dominion occur in the vicinity of Quebec, and the delay in melting this covering accounts for the April temperatures being 5 degrees colder here as compared with Montreal.

The outstanding climatic feature of this part of the world is the frequent passage of cyclones on their way to the Atlantic. World charts show that such storms are more frequent here than in almost any portion of the globe; and several interesting climatic characteristics follow from this constant procession. There are unusually rapid changes in weather during any given week, depending on whether a locality is affected by the warm front or cool rear winds of the cyclone. The rainfall is remarkably reliable, since one of the chief rain-producers—the cyclone—crosses the area every few days. These rapid changes are of course not apparent from monthly average figures, so that special mention must be made of the 'weather' of the St. Lawrence. The St. Lawrence River at Montreal is closed to navigation in normal years about December 16, and is not open again until April 21.

Some interesting features are presented in Fig. 47, where hythergraphs of Quebec, Montreal, New York, London, and Moscow can readily be compared. The long narrow graph for Montreal means that it has a uniform rainfall, while the broader graph for Quebec shows that the rainfall of the fall is much greater than that in the spring. Indeed, the spring months in Quebec are not unlike those of London, as is clear from the graph.

There are no very close homoclimes, though Moscow in Russia must be fairly close in this respect to Ottawa, whose graph is not given. The summers of Montreal and New York have a good deal in common. Both of our Quebec stations have pleasant summer climates, as is evident from their position within the rectangular 'comfort frame'; but their winters are too cold to appeal to any but a home-grown Canadian. The region is part of Köppen's Dfb area; and perhaps could be usefully compared with the climates in southern Manchuria. However, no detailed figures for the latter are at hand.

There are two types of forest vegetation in this region, depending essentially on the elevation. In the eastern Gaspé area the plateaux carry boreal types such as black and white spruce with a good deal of white birch. Across the St. Lawrence River to the north the higher ground also grows a good deal of balsam fir. In the rather deep juvenile valleys many of the low-level trees, such as cedar, maple, and elm, may occur. South of Quebec City in the 'Eastern Townships' the boreal type gives place to Halliday's 'Great Lakes

Forest', but there is no very sharp line of division. White spruce and balsam fir are still quite common, but the hardwoods, sugar maple and yellow birch, with cedar in the swamps, are much more abundant than in the boreal areas. Around Rivière du Loup cedar is the most characteristic species, and its wood gives rise to many shingle mills. Black spruce and tamarack are frequently present, especially in the lower lands. In the Saguenay region the marine clays around Lake St. John support sugar maple, yellow birch, and white pine; but some intrusives from the surrounding boreal forest, such as aspen, white spruce, and balsam fir, are encountered.

Gaspé and the Shickshock Districts

The population map of this part of Quebec Province shows merely a fringe of settlement around the coast of the peninsula, with some broadening of the occupied territory in the hinterland of Rivière du

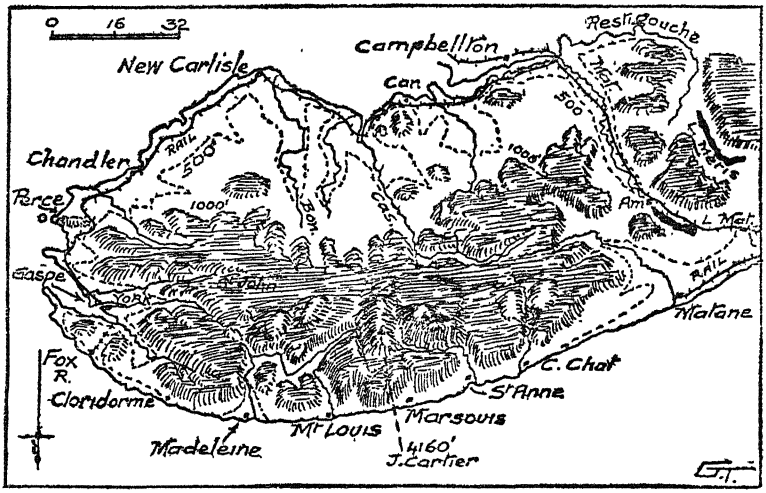


FIG. 49.—A sketch diagram of the peninsula of Gaspé, looking southward from the Gulf of St. Lawrence. The 500- and 1,000-feet contours are indicated

Loup. The north coast from Matane to Gaspé town contains many small fishing villages, such as St. Anne and Madeleine, which are crowded in the narrow lowland at the base of the precipitous cliffs.[1] An excellent highway has led to a considerable growth of tourism in this region. The very picturesque cliffs bordering this extension

[1] This region is fully described in an article by the author in the *Canad. Geog. Jnl.*, June 1945. See also R. Blanchard *L'Est du Canada Français*, Montreal, 1935.

of the Appalachians terminate at Percé in the romantic 'stacks' of Bonaventure and Percé Island. Along the south shore the soils are poor, and the farms do not extend back more than a mile or so from the shore.

The chief industries are naturally associated with the forests, and there are small sawmills in the vicinity of most of the towns. Water-power is abundant, and many of the short steep rivers have been utilized for this purpose, especially at Rivière du Loup and Priceville on the Metis River. The falls on the Madeleine have not yet been utilized. Giant sawmills are to be found at Cabano near Lake Temiscouata, and near the town of Gaspé at the end of the peninsula. Chandler on the south shore near New Carlisle has a large paper-pulp mill, but this district is mostly agricultural. Potatoes are the chief crop, while dairying, sheep, and poultry occupy the farmers here as well as on the northern shores. A very little petroleum has been found on the shores of Gaspé Bay; and there is some unimportant mining for zinc and lead in the southern Shickshocks.

Saguenay and the Lake St. John Region

We owe to R. M. Glendinning[1] a very clear account of the effect of environment on settlement in the interesting isolated

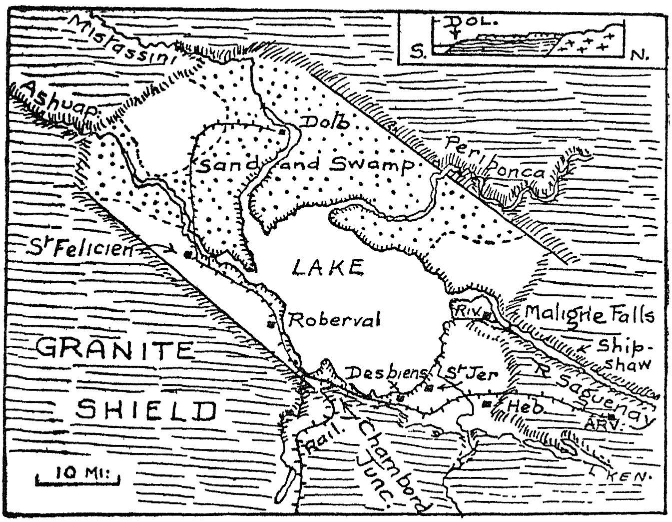


FIG. 50.—A diagram of the shallow Graben occupied by Lake St. Jean at the head of the Saguenay River. *Dol.* is Dolbeau; *Arv.* is Arvida. (Partly based on R. M. Glendinning) (See also map on p. 379.)

[1] 'Michigan Papers in Geography', *Ann. Abor.*, 1935.

community of Lake St. John at the head of the Saguenay River. The diagram given in Fig. 50 is somewhat simplified from his maps. There seems little doubt that we are dealing with a *graben* with major fault-boundaries (running north-west to south-east) on both sides of the oval lake which occupies the central parts of the *graben.* This area of about 50 miles by 25 miles has been depressed many hundreds of feet below the adjacent granite plateau of the Laurentian Shield. The scarp is about 500 feet above the lake behind Desbiens, but is not so high to the north-west of St. Félicien.

Large rivers, tributary to the Saguenay, have been busy filling in this hollow, which for a time was an extension of the Post-Pleistocene Champlain Sea mentioned earlier. The typical geological section is shown as an inset in Fig. 50. The marine clays of the Champlain period have been covered by river silts, which were laid down in several layers giving rise to well-marked terraces. These patches of sandy silts, &c., are naturally most extensive at the mouths of the main rivers, Peribonca, Mistassini, and Ashuapmouchouan.

The abundant waters of these rivers after flowing through the lake enter the Saguenay by two outlets. Falls and rapids mark the river at this point; and two of the largest hydro-electric plants in Canada have been developed here. The first great plant harnessed the water at Isle Maligne, while a larger war-project has been developed at Shipshaw a little further down the Saguenay.

The better farms are found on the marine clays, chiefly on the southern shores of the lake. These are fairly well drained, while the sandy areas around the northern half of the lake are distinctly swampy and badly drained. This is due to the fact that the sands lie immediately over the clays, as is obvious from the inset section at Dolbeau (Fig. 50). The region is predominantly interested in dairies, for the shortness of the growing season (barely three months) prevents the growth of most crops. However, oats and potatoes, as well as large hay crops, are general throughout the district.

The region is reached by railway from Quebec via Chambord Junction; or by the river steamers on the Saguenay which serve the rather large towns of Chicoutimi and Kenogami just outside our map. The settlers are almost all French; and most of the towns and villages are of the *strassendorf* type, i.e. the houses are strung out along the main roads. In the south-east the town axes run nearly east and west, but in the north-west portion of the area the roads and axes run north-west to south-east. Hebertville, Roberval, St. Félicien, and St. Jerome are small dairying towns; while Riverbend (with St. Joseph) is a large industrial town based on the Maligne Falls. Other smaller towns due to adjacent water-power have grown up at Dolbeau and Desbiens. Many cheese and butter

factories are scattered throughout the fertile clay areas in the south-east. Arvida is a new industrial city (based on the abundant water-power) which has grown up during the war. It lies about 25 miles to the east of Maligne in the vicinity of Chicoutimi and Bagotville (Fig. 50). Arvida is now one of the great centres of aluminium production, the ore coming from British Guiana. (Population 11,000.)

The River Saguenay occupies a valley which has been much deepened in the past by glacial action. It flows some 400 feet below the plateau in the vicinity of Kenogami, but the cliffs become higher and higher as the river flows east to the St. Lawrence. Not far from its mouth on the southern shore are the famous cliffs known as Capes Trinity and Eternity. The latter towers 1,800 feet above the river, which is about 800 feet deep at this point. Tadoussac is a little tourist town at the mouth of the Saguenay. It has the distinction of being the oldest settlement in Canada, for Chauvin built a fur-trading post here in 1599.[1] Good roads only extend about 100 miles to the east of Tadoussac to Bersimis.

The Environs of Quebec

From Tadoussac to Quebec is a little more than 100 miles, and a good road extends along the coast, passing at times through a broad (fault ?) valley, parallel to the coast, but usually winding up and down hills just near the coast. The Shield forms a plateau from 1,000 to 2,000 feet high just behind the coast, and there is very little settlement except in rather broad deep valleys such as those near St. Simeon and Malbaie (Murray Bay). At this last town is the eastern end of railways north of the St. Lawrence. It is a popular tourist resort, and there is a huge hotel on the site of the famous Manoir Richelieu, which is operated by the Canadian Steamship Lines, Ltd.

The general environment of this northern coast can be understood by studying the block diagram of the environs of Quebec (Fig. 51). Here is the head of the broad lower St. Lawrence, and beyond this point sailing ships found it hard to proceed. Hence Quebec was for many years the entry port for the settlements near the Great Lakes. The Isle of Orleans here splits the main channel, rising about 450 feet above the river.

Quebec itself is built on another similar elevated block (horst), but in this case the former northern channel is now a flat plain above river level, and supports many flourishing farms. The lower St. Charles River flows therefore in a relatively depressed area (or *graben*), while the St. Lawrence River itself today only occupies the southern depression round the Quebec Horst. There are several

[1] A description of this oldest establishment (with a map) is given in *Canad. Geog. Jnl.*, June 1945. (St. John's (Newf.) perhaps started in 1580.)

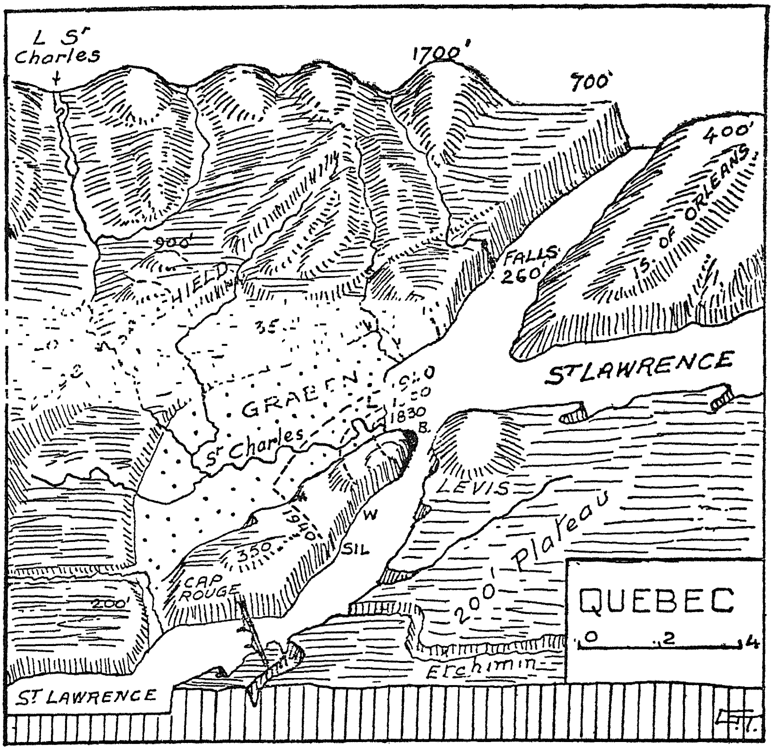


FIG. 51.—Block Diagram of the vicinity of the City of Quebec, whose limits are shown in 1830, 1900, and 1940. Note the Quebec Horst and the St. Charles Graben. Basse Ville, Wolfe's Cove, and Limoilou are indicated by initials, also the Montmorency Falls

major faults in the vicinity of Quebec, and earthquakes due to slips along these are not uncommon in this region. One such fault seems to bound the Canadian Shield, which is much higher than the Paleozoic rocks found in the *horsts* and *graben* just described.

The river is less than a mile wide at two points near Quebec. One such narrow portion is crossed by the numerous ferries to Levis (Fig. 51), while the other about 7 miles to the west is the site of the famous Quebec bridge, which is shown in the diagram. The eastern end of the horst forms Cape Diamond, and here the Citadel was built. The city was founded by Champlain in 1608, who built a fort on the low ground of the Basse Ville (shown black in Fig. 51).[1] Many large stone buildings in the Haute Ville, including schools, monasteries, churches, &c., date back to the early French occupation,

[1] The evolution of Quebec (with 4 maps) is discussed by the author in *Canad. Geog. Jnl.*, June 1945.

and make the city the most interesting in the Dominion. The crucial battle for the Dominion was fought between the French and English in what is now the centre of the city, to the north-east of Wolfe's Cove (W. in Fig. 51), where Wolfe's troops climbed to the summit of the horst (September 1759). The striking walls and picturesque gates belong to the English regime, and were built between 1823 and 1832.

For many years Quebec was the chief city of Canada, but this position was later taken by Montreal, which could easily be reached by steamers, and which lies at the foot of a long series of rapids soon bypassed by several canals. In recent years, however, the largest steamers find the deeper water at Quebec advantageous, so that Quebec has become a great ocean port again. It was noteworthy as a great shipbuilding centre in the days of wooden ships; and it has exported an immense amount of timber, both as logs and partly dressed, throughout its history. The cheap labour available has led to the development of many small factories. Shoemaking started on a large scale in the 'seventies, while port facilities were much increased about the same time. Other products are leather, corsets, tobacco, and textiles. The industrial population spread to the north in the lowlands at the mouth of the St. Charles, and Limoilou (L. in Fig. 51) consists largely of their homes. The English citizens live for the most part near the Haute Ville to the west of the walls, which run where the line for 1830 is shown on the diagram. Today the population is 170,000, of whom less than 15 per cent are English.

The Eastern Townships

This portion of Quebec lies on the south side of the St. Lawrence River to the south-east of Quebec City and Montreal. As stated, its structure is based on the folds of the Appalachians, but these have been eroded through the long ages since their uplift, and the dominant land-form is an incomplete peneplain which Blanchard calls the Appalachian Platform (Fig. 46). Its elevation is about 1,000 to 1,500 feet, but numerous monadnocks rise considerably above this height. Rivers have cut valleys in the platform, and they flow naturally to the north-west to the St. Lawrence. However, the upper waters often run at right-angles to this direction, and this is due to the influence of the Appalachian folding. In the lower portions of the region marine clays, laid down in the Champlain Sea, form fair agricultural soils. The glacial deposits are of course almost universal throughout the area.

The first settlers were French who ascended the Chaudière valley from Quebec. After the conquest, however, there was a large influx of Loyalists, and also of Americans from the adjacent states to the south. The outstanding sociological feature of this region is the

way in which this early population has been swamped in the later growth of the French settlers. The English, Scotch, and Irish were tempted by the new lands opening farther to the west, while the French were not so attracted, and their large families gave them the majority about 1865. There are now 300,000 French Canadians and only 50,000 British in the Eastern Townships (Brouillette).

There is no large town in this region, for the largest (Sherbrooke) has only 59,000 inhabitants. Yet, as we shall see, the region is noted for its industrial rather than for its agricultural development. The growth of cereals has diminished considerably in recent years, and potatoes form perhaps the chief crop. Dairying is universal, and hogs and poultry are quite important throughout, with many sheep in the south-east. There are more than 250 butter factories, mostly in the vicinity of Sherbrooke, while the supply of milk to Montreal and Quebec employs many farmers (p. 392).

The earliest manufacture was the production of potash from the ashes of the trees cleared from the early farms. This has, however, long since been given up, but the production of maple sugar, another early industry, is still of considerable importance. There is a large sugar factory at Plessisville, and maples are especially numerous in the Chaudière valley. Another industry depending on the forest is the construction of furniture of all kinds, of which the chief centre is near Victoriaville. Pulp-mills for the production of paper are chiefly to be found in the valley of the St. François, while paper and card materials are fashioned at East Angus, Drummondville, and Sherbrooke. Granby, Magog, and Richmond have large factories connected with various textile industries.

The mining industry in Quebec has risen from values below 2 million dollars around 1900 to more than 250 millions in 1953. Most of these valuable minerals are found in the far west of the province in the Shield (p. 416). But the Eastern Townships possess one unique asset, the most productive source of asbestos in the world (Fig. 134). It furnishes about 65 per cent of the total supply, its sole rivals being Rhodesia and Russia. The chief mines are at Thetford and Black Lake (p. 431). Quarries for limestone, marble, and granite are of minor importance.

Montreal and Adjacent Districts

The last section to be discussed in our study of southern Quebec comprises the north shore of the St. Lawrence from Quebec westward to the common boundary with Ontario (Fig. 52). This district is an elongated block of Paleozoic rocks which border the great Shield, and probably are separated from the latter by various faults, much as we have seen at Quebec City. The strip of younger rocks is wider here than at Quebec, and hence the agricultural hinterland

is more important. This rather narrow strip, much of which contains only poor soils and which lacks any rich supply of coal or metals, contains, however, the largest city of the Dominion. As the French geographers have pointed out, it is clear that unusual port facilities such as belong to Montreal can offset disabilities which might be thought to prevent the growth of a large city.

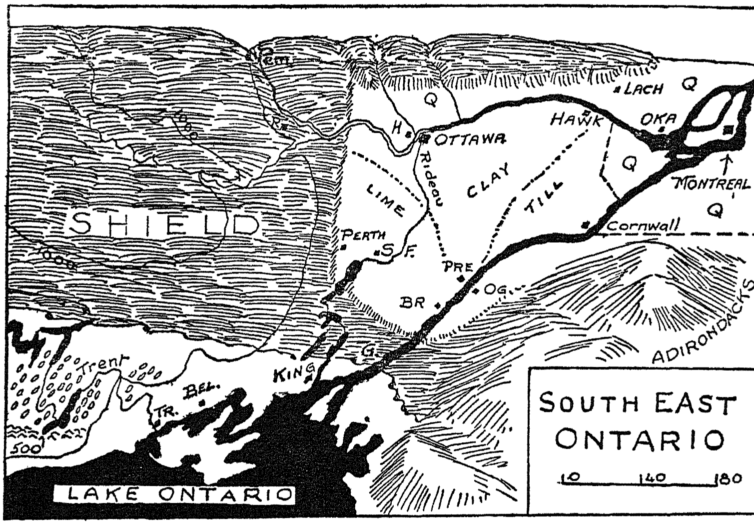


FIG. 52.—The structure and physiographic features of south-east Ontario. Drumlins are shown by ovals. (See also inset, Fig. 38)

Montreal then is pre-eminently a meeting-place of great lines of communication. As mentioned earlier, it is the head of navigation for large steamers, for the Lachine Rapids block the St. Lawrence immediately to the west. In earlier days voyageurs by canoe had to surmount six important rapids with a total fall from the level of Lake Ontario to Montreal of 227 feet. Early in the nineteenth century canals were cut alongside these rapids so that vessels drawing not more than 14 feet can now reach Lake Ontario. The construction of a deeper Ocean highway has recently been completed. However, Montreal still remains the chief entrepôt for the Dominion, and is said to be second only to New York in the whole continent, and the world's greatest grain port. It is also the centre of the chief pulp-producing region in the world; and is the headquarters of two large railway systems, the Canadian Pacific and Canadian National.

The city is situated on the larger of two oval islands which almost block the St. Lawrence.[1] The main channel flows along the eastern

[1] There is a valuable study of Montreal published by École des Haute Études commerciales (Éditions Fides), Montreal, 1943.

shore of the Island of Montreal, and the other two channels are of little importance. Leading directly towards Montreal is the important tributary, the Ottawa River. This was the great line of communication in the early days with the upper Great Lakes, for the voyageurs feared the savage Indians of the Erie region, and could not readily by-pass the Niagara Falls. Another route of much importance, though not quite so direct, leads up the Hudson from the vicinity of New York to Lake Champlain (Fig. 46). Thence it was only a short journey of 10 miles via St. Jean or Chambly, to the St. Lawrence at Montreal. The first railway in Canada was opened in 1837 across this short stretch, to serve the traffic from the south, which was blocked by the Chambly Rapids (Fig. 145).

The population of Montreal in 1956 was 1,109,000, placing it about 280,000 ahead of Toronto. A very large proportion of this number consists of folk of French culture, so that Montreal is the second largest French city in the world. In addition to the vast export of grain, flour, lard, cheese, paper-pulp, metals, &c., the city imports enormous amounts of petroleum, coal, and sugar. It is also a great industrial city, manufacturing railway materials, shoes, confectionery, and beer.

In the farmlands which form the hinterland of Montreal the products are much the same as those described from the Eastern Townships. Dairy, hogs, poultry are universal, while sheep and tobacco are important in some districts. Of course some grains are grown, but these are charted in a later section (p. 392). There are a number of small towns, such as Lachute and St. Jerome; but Three Rivers is the only town of note besides Montreal.

The St. Lawrence widens to form Lake St. Peter half-way between Montreal and Quebec. At the eastern end of this lake one of the chief tributaries of the St. Lawrence, the St. Maurice, enters from the north (Fig. 46). At the junction has developed the little city of Three Rivers with a population of about 50,000. Where this river leaves the granite platform of the Shield at Shawinigan are imposing falls, and these have been harnessed to provide 152,000 h.p. At Three Rivers is a large paper-mill with 3,000 hands, and a somewhat smaller textile mill. Lumber and grain from the hinterland are also exported.

NATURAL REGION 3: SOUTHERN ONTARIO

The boundaries of this region are somewhat hard to define on the northern side, though its limits are clear enough on the other three sides. It extends from the Quebec boundary to the St. Clair River and Lake Huron. The southern edge is of course the St. Lawrence, but there is no very clear limit on the north, since the rather rough sterile areas of the Shield offer many attractions to

tourists and holiday-makers from the settled areas to the south. This type of population is closely linked to the southern folk, and renders the southern edge of the Great Shield not altogether satisfactory as the limit of a natural region, though agriculturally the geological control mentioned is very definite. The famous lake regions known as Muskoka and nearby Algonquin Park must therefore be discussed as linked with Toronto, but districts farther north will be described with the adjacent Claybelt Region (Fig. 53).

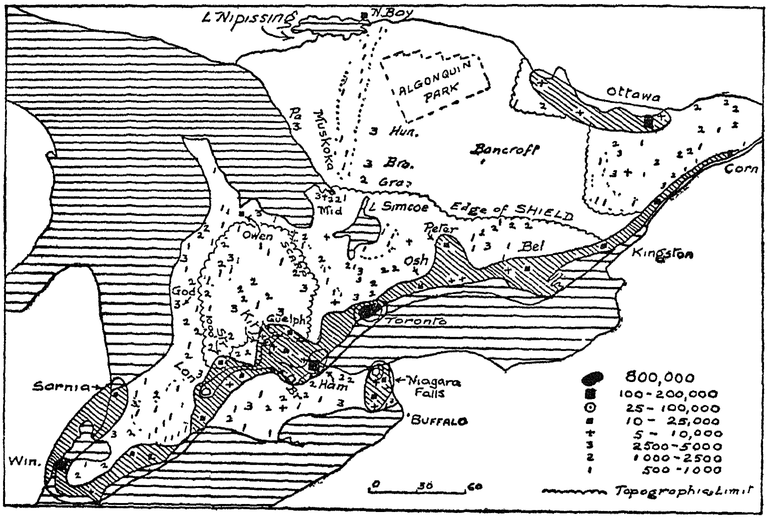


FIG. 53.—Distribution of towns in southern Ontario, classified according to population in 1931. (Partly based on Schott)

'Southern Ontario' therefore is the region south of Lake Nipissing and the Ottawa River, and it may be conveniently divided into four sections. The South-east section (' Ottawa ') includes the district around Ottawa and the interesting Frontenac Anticline; the central section (' Toronto ') centres on the capital of the province and extends north to the edges of the Shield ; the south-west section (' Peninsula ') includes the Niagara Cuesta, and the peninsula to the west between Lakes Erie and Huron ; the fourth section consists wholly of the Shield and may be labelled the 'Muskoka and Algonquin' district.

Climate and Vegetation in Southern Ontario

Since the principal isopleths of climate run more or less parallel to the St. Lawrence, there is not much difference in the climates of southern Ontario and southern Quebec. The mean annual range in

the former region is about 54° F., and it lies on the warmer border of Köppen's Dfb province. The most southern point in Canada is Point Pelee in latitude 42° N. (Victoria, B.C., is in latitude 48° N.). The author on his first visit was surprised to find that tobacco, vines, and maize (for husking) were staple crops in this corner of the cool Dominion.

Toronto and Parry Sound may be taken as fairly representative of this region. The former has a January temperature of 22° F., and 69° F. in July. The rainfall, as seen in Fig. 48, is nearly uniform and amounts to 32 inches a year. Parry Sound on Georgian Bay has a range between 13·6° F. in January and 67·2° F. in July; while the rainfall amounts to 39 inches, with a spring minimum. The onset of spring, which we may define by a daily temperature of 42° F., has been mapped by the writer. It reaches Point Pelee about the 5th of April, Sarnia about the 12th, Toronto on the 14th, Ottawa on the 16th, Muskoka on the 21st, and Algonquin Park about the 26th of April. (See map 3 in Fig. 124.)

A glance at the hythergraphs charted in Fig. 48 shows, as stated, that Toronto has a remarkably uniform rainfall, indicated by the *vertical* long axis. Its regime is indeed much like that of New York, save that Toronto is about 8 degrees colder throughout the year. Parry Sound has a much wetter, colder, winter as indicated by the bulge towards the 'Raw' corner of the Diagram. There do not seem to be any near homoclimes in the Old World of these climates in southern Ontario. Kiev in Russia is not unlike Ottawa.

Halliday makes a special vegetation section for the shores of Lake Erie and the Niagara Peninsula. Here indeed are found a number of deciduous trees not known elsewhere in Canada. Chestnut, tulip-tree, hickory, various oaks, black gum, magnolia, papaw, redbud, and sassafras have their northern limit in this district. The conifers are rather rare and are represented by some hemlock and juniper.

The forest in the region south of the Shield in southern Ontario is generally broad-leaved with sugar maple and beech dominant. Other common trees are basswood, white birch, while white and red pine are found on the lighter soils, though the larger trees have mostly been cut long ago. Of course, very large areas have been cleared; but copses, wood-lots, and swampy lands still preserve much of the original forest cover.

Where the bed-rock is granite as in the great Shield, the white pine probably reached its maximum development, but extensive lumbering and fire have removed the greater part. Red pine is abundant, especially in the Algonquin Highlands. Naturally some members of the boreal forest are present, so that the trees represent a transition region. On the whole, it may be stated that sugar

maple, yellow birch, hemlock, and white pine are the dominant trees (Halliday). In the west near Georgian Bay in the thin-soiled rocky plateau the jack pine is dominant, mixed with aspen and other trees of the genera already mentioned.

The South-east 'Ottawa' District

The general features of the structure of this district are charted in Fig. 52. The capital city of Ottawa is seen to lie on the northern edge of a triangular area of Paleozoic rocks which overlie the dominant granites of the Shield. Linking this huge area of granites to the similar rocks of the Adirondacks is a narrow belt of Shield which forms most of Frontenac County, and is accordingly known as the Frontenac Axis (or Anticline). Here some slight upward bulge of the crust has led to the Paleozoic 'mantle' being removed by erosion to expose the underlying granites. This hard rocky bar across the St. Lawrence accounts for the highest of the series of rapids in the river. The 'Thousand Isles' off Gananoque (*pron.* Gàn-a-nòk-wee) also form part of the granite barrier. The Adirondack Mountains consist of an upwarped mass of the Shield which has been much affected by faulting (Fig. 52).

The Paleozoic rocks consist essentially of level-bedded Cambrian and Ordovician strata which have been somewhat warped and faulted. However, as suggested in an earlier diagram (Fig. 38) the whole area is covered with glacial debris, which appears as rather deep till near the St. Lawrence, but has been sorted into beds of clay and sand near the Ottawa River. During the Champlain Sea period the sea formed a wide gulf up the Ottawa valley and was 400 feet deep near Ottawa. The till is richer in lime in the vicinity of Perth.

The whole district hardly rises anywhere above 500 feet, and this contour line is indicated in Fig. 52 as lying west of Perth. The chief rivers flow into the Ottawa, and the Rideau River was linked to the Lake Ontario by a canal in 1831, so as to obtain a water route from Montreal which was not too near the boundary of the United States. It is still kept in order, though only one or two boats use it for carrying cargo. It is frequented by pleasure craft, and the various small falls associated with the canal are still a source of water-power for a number of small grist mills. Smith's Falls and Perth are two of the largest towns near the canal. The country as a whole is devoted to farming, especially dairying and the growth of hay, oats, and silo maize.

The main towns are found on the borders of this district. Ottawa is the capital of the whole Dominion and has a population of 222,000. It is very pleasantly situated on the high shore south of the Ottawa River at the Chaudière Falls, where there are rapids about 50 feet high. The region was first settled in 1800, and the falls were soon

utilized by sawmills. In 1858 this small town, hitherto known as Bytown, was chosen as the capital, and given the name Ottawa. The city is built in the conventional grid pattern on both sides of the Rideau Canal, which joins the Ottawa River somewhat to the west of the junction of the Rideau River. The fine House of Parliament is built on a bluff about 160 feet above the river. There are many large public buildings and a number of imposing churches. The lumber trade and industries based thereon are still very important at Ottawa, especially at the suburb-town of Hull across the river in Quebec.

Along the St. Lawrence are a number of towns of some note, such as Cornwall which has grown up at the foot of the Long Sault Rapids, with a population of 18,000. It has a number of factories in part based on the local power. Furniture, paper, pulp, and some textiles are produced. Prescott is a smaller town with a population of about 3,000. It has large grain elevators, a creamery, and planing mill. Brockville is a larger town in the centre of a prosperous dairy district. It is a tourist centre for fishing and island trips. On the middle Ottawa River are the towns of Renfrew and Pembroke. The latter has a number of machine shops and foundries as well as the usual small factories associated with a lumber and dairying region. The drop in population due to the sterile soil of the Frontenac Anticline near Gananoque (G. in Fig. 52) is very perceptible in density maps. The great abundance of small lakes hereabouts is also due to the character of the surface of the Shield. The hard granites have prevented the development of a normal drainage (in the glacial debris, &c.), which has to a large extent had time to develop in the softer Paleozoic rocks since the close of the Ice Ages.

The Central 'Toronto' District

The main topographic feature in this portion of the region is the Niagara Cuesta. A glance at Fig. 54 shows this scarp running up the middle of the district in a north–south direction, and separating the lower land near Toronto from the oval area which is labled 'over 1,000 feet' to the east. This scarp is about 250 feet high, and appears as a marked cliff behind Milton; but in other places the scarp has been covered with deep moraines, e.g., near Orangeville (OR.). To the north of the region it extends into Lake Huron, forming the very well-marked feature called the Bruce Peninsula. The geology of the district is shown in Fig. 38.

In an inset in Fig. 54 the salient features of the Ice Age are sketched. The northern portion of the area was covered with a great ice mass called the 'Huron Lobe', while the southern portion was largely covered by a similar 'Ontario Lobe'. Between the two was a large lateral moraine, which today is the chief topographic feature

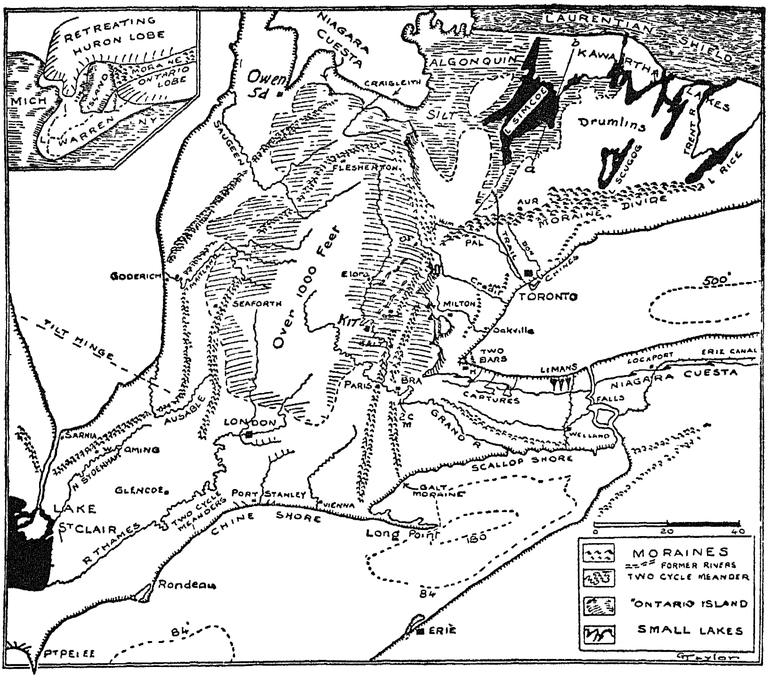


FIG. 54.—Topography of the Toronto Region, and of the Niagara Cuesta and Peninsular Ontario. Inset is a diagram of former Ice Lobes

to the north of Lake Ontario. It takes the form of a pile of tumbled glacial debris several hundred feet high, which is labelled the 'Moraine Divide' in the sketch map. As the Huron Lobe melted, a large lake was left which is known as 'Glacial Lake Algonquin'. Today we see relics of this lake in the form of Lake Simcoe, and in the widespread Algonquin lake-silts to the west of that sheet of water. So also the precursor of Lake Ontario was a much greater lake, which is known as 'Glacial Lake Iroquois'. Beaches and deposits along these glacial lake shores are prominent minor details in the district between Lakes Ontario and Huron. In the same way a precursor of Lake Erie is known as Lake Warren, and its main features can be made out in the inset to Fig. 54.

Other moraines of considerable size bordered the snouts of the ice lobes. These appear today as crescentic moraines which have recently been charted in considerable detail by Putnam and Chapman. Their main features are shown in Fig. 54, extending all around the more elevated portion of the region.

The whole region is covered with glacial debris, though it is quite thin on the elevated region south of Flesherton. The under-

lying rocks are shown in the inset to Fig. 38. All are dipping at a low angle to the south-west, and range from Ordovician in the east to Devonian in the west. The Black River Limestone is much used for building in the Kingston area. The Dundas Shales at Toronto are valued sources of brick clays ; while there is a little petroleum present in the Trenton rocks (and others of Devonian age) deep down in the vicinity of Petrolia (20 miles south-east of Sarnia). The Upper Silurian rocks in the vicinity of Windsor contain a good deal of salt, and the Lockport Dolomite, which helps to form the great cuesta, is much used for buildings in this region.

All the early towns developed along the shores of the great lakes, as settlers spread from east to west. Kingston (Fig. 53) was founded by Count Frontenac as early as 1683, but received its present name from the Loyalists who arrived about 1781. It is a pretty little city of 49,000 inhabitants, and is marked by a large number of houses built of the local limestone. Queen's is a well-known University, and here also is the Royal Military College. Kingston is also the site of the new Military Staff College. It collects the agricultural products of the immediate hinterland, and is at the southern end of the Rideau Canal, though this is of little importance today.

Belleville, with a population of 19,500, is another town with mixed agricultural and industrial interests (Fig. 53). Small factories produce machinery, flour, textiles, canned foods, cheese, &c. Trenton (10,000) is at the mouth of the Trent River, which forms part of a lengthy canal system linking Lake Ontario to Georgian Bay by way of the Kawartha Lakes, Lake Simcoe, and the River Severn. This canal, like the Rideau Canal, is kept going chiefly for the benefit of the small mills (based on water-power) rather than for any value it has in shifting cargoes. Port Hope is notable as the site of the chief radium extraction plant in the world. The ore comes from the Great Bear Lake in the far north-west. Oshawa (Fig. 53) is one of the most important industrial towns in Ontario, its chief products being the automobiles made by General Motors. Machinery, bottles, pianos, glass, and textiles are also manufactured. The population was 50,000 in 1956.

Toronto is one of the great cities of the British Empire, and had a population of 1,117,470 in 1951.[1] It is indeed the largest British city in the Dominion, for Montreal is mainly of French culture. It was founded in 1793 by Governor Simcoe, though there had been

[1] For a fairly full study of the city and of the physiography of the region surrounding Toronto, see the article by the writer in the *Canadian Journal of Economics*, Toronto, November 1936. A stage-diagram giving the evolution of Toronto appears in my address to the American Geographers, (*Annals*, p. 40, March 1942). See also my *Urban Geography* (London, 1949).

a French post here since about 1749. It owes its origin to the sandy hook, which encloses the best harbour in this part of Lake Ontario. The city centre was originally at the junction of King and George Streets at the head of the bay, but is moving to the north-west, and is now at the junction of Yonge and Queen Streets. It has now spread for a distance of about 12 miles along the lake-front, and extends about 6 miles back along Yonge Street, the old road to the interior. The 'City Plain' is about 2 miles wide north of the lake, and lies below the well-marked cliff cut by glacial 'Lake Iroquois'. The suburbs spread up this 40 feet cliff about 1890, and the later suburbs now cover the northern higher ground to an elevation of some 400 feet above the lake. The Don and Humber Rivers have cut ravines some 200 feet deep in the thick glacial deposits on which Toronto is built, and these are crossed by unusually large viaducts.

Toronto is the capital of Ontario and the seat of the largest University in the Empire.[1] It is a very important railway centre, and its shipping will undoubtedly increase greatly in volume now the St. Lawrence Deep Waterway is completed. A good deal of the western wheat comes by rail from Georgian Bay (Midland, Collingwood, and Owen Sound) to Toronto, the nearest port on the St. Lawrence. The first railway reached the city in 1853, and linked Toronto with Lake Simcoe along the ancient Indian Portage. Unlimited hydro-electric power reaches the city's factories from Niagara Falls. In 1952 there were 3,825 factories (with 149,000 employees) in the city, and these figures have been largely increased as the result of Second World War activities. There are several large airports in the west of the city, and the largest stock-yards in the province are also in Toronto.

The hinterland of Toronto is a rich agricultural region, whose crops and soils have been described previously (p. 103). Barley, potatoes, oats, and hay are perhaps the chief crops grown; and Peterborough and Lindsay are the largest inland towns. To the north-west of Lake Simcoe on Georgian Bay are several small ports such as Midland and Owen Sound. The former has a population of about 7,000, and contains a number of factories and machine shops which are largely connected with the transfer of wheat from the lake steamers to the railway. Owen Sound has about 16,500 inhabitants, and there are 52 factories supporting 2,700 employees in the vicinity (Fig. 53). These produce flour, textiles, machinery, furniture, &c.

Ontario 'Peninsula'

One of the most interesting clusters of towns in Canada is situated to the west of Lake Ontario in or near the middle Grand River.

[1] See note previous page.

Hamilton (240), Brantford (52), Galt (24), Guelph (34), and Kitchener (60), are all important towns which have passed through much the same evolution. They started as nuclei of a farming population.[1] Soon the small streams were harnessed to give power to grist-mills and sawmills. The growth was slow until railways put them in closer contact with the outside world, whereupon the factories were considerably expanded. In later years the use of electric power from Niagara has spread widely in this Grand Valley area. Hamilton has a University, and its position on the lake has made it especially accessible. Very large steelworks have developed on the shores of the lake at Hamilton. It ranks second to Toronto in the number of its factories, which total 560. Kitchener is fifth in the province with 199 factories (Fig. 143).

The richest agricultural land in Ontario lies in the vicinity of London and Woodstock in the centre of this peninsular area. Here are grown the largest quantities of silo maize, hay, and oats, while dairy cows are densest in the same region. Tobacco and wheat are found in the south-west near Windsor and Chatham, while the Niagara Peninsula is noted for its orchards and vines. Windsor (122) and London (103) are second only to Toronto and Hamilton as manufacturing centres (Fig. 53). The former is just across the Detroit River from Detroit, and many of the American firms (such as Ford) have huge establishments on adjacent Canadian soil. St. Catharine's (38) and Niagara Falls (23) are small factory towns, whose industry is based on the plentiful supply of electric power from the adjacent Falls.

The Muskoka-Algonquin District

Any detailed map of southern Ontario, whether it stresses roads, crops or population density, indicates clearly that there is a great change as one passes north on to the granites in the Shield. In Fig. 53 the distribution of the towns is seen to lie in a definite pattern. As stated, almost all the important towns lie along the St. Lawrence Corridor. There is a fairly uniformly distributed arrangement of small towns north of this 'Corridor'; but to the north in the Shield there are only three small towns (Gravenhurst, Bracebridge, Huntsville) on the main route to the north, and Parry Sound on Georgian Bay.

All these towns are situated on rather sterile soils consisting of fragments of the granite Shield deposited by the vanished ice-cap. It would be wrong to picture this area as devoid of farms, but they are only numerous near the main north road and are mainly devoted

[1] Two recent articles on this region have appeared in *Economic Geography* (Worcester): 'Dairy Farming in Peninsular Ontario' by J. R. Whitaker, in January 1940; and 'Middle Grand River Valley', by C. Lee, in April 1944. The figures in brackets indicate populations in thousands.

to pasture. Many have been abandoned as the owners have moved off to better soils. The great assets are the innumerable small lakes and rivers often bounded by picturesque granite cliffs. The two best-known areas are the Muskoka Lakes—a group of three on a north-west to south-east axis with Gravenhurst at the southern end; and the Lake of Bays and its neighbours about 30 miles to the north-east, of which Huntsville serves as the shopping centre. Here thousands of tourists flock in the summer not only from Toronto but from many towns in northern United States. There are excursion steamers on the lakes, many elaborate camps, and thousands of residences ranging from large houses to the flimsiest of shacks. Algonquin Park is a national reserve of 2,741 square miles, with a government hotel and many licensed smaller dwellings, in the north of our area.

This wide region is served by the Canadian National Railway running north to Callendar and North Bay (both on Lake Nipissing). The Canadian Pacific Railway runs near to Georgian Bay through Parry Sound. An old lumber railway from Parry Sound to Ottawa crosses the Park, but the central portion of this line is no longer in use. Some small mines are worked in the Shield, especially near Madoc (fluorspar) and Bancroft (sodalite and mica). Graphite and corundum occur near Renfrew to the south-east of the Park.

NATURAL REGION 4: LAKE SUPERIOR SHORES

This is a very arbitrary subdivision embracing the great highways between the Eastern Settlements and the Prairies (Fig. 55). It lies

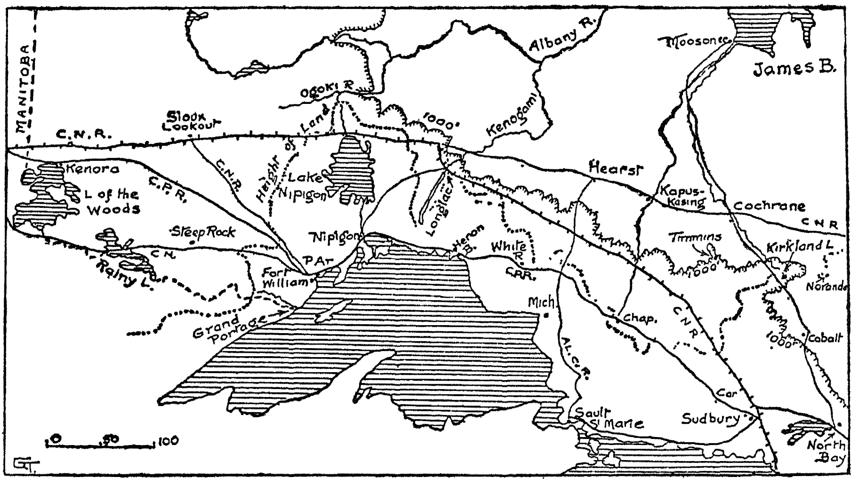


FIG. 55.—The eastern and northern shores of Lake Superior—showing the main divide (dotted) and the 1,000-foot contour

entirely within the Canadian Shield, so that the three centres of considerable population cannot be based on croplands. One of these is Sudbury, the world's greatest nickel field, the other two are Sault St. Marie and Fort William; and these are very largely traffic centres, partly of railway and partly of steamer services. Three main railways cross this part of the Shield, for we may extend our region to include the area between Lake Superior and Manitoba. The main C.P.R. runs from Sudbury to White River, and then skirts the picturesque coast of the lake from Heron Bay to Fort William. The later-built Canadian National Railway traverses a belt of country about 50 miles to the north of the C.P.R. to Longlac, where the main line passes north of Lake Nipigon to Sioux Lookout. The other branch from Longlac turns south-west to Fort William. The third railway (Algoma Central) runs north from Sault St. Marie to Hearst on the C.N.R.

There are railway stations every few miles along these railways, but in general they serve only a few houses and isolated farms. Every hundred miles or so there is a 'Division' station, where a little town of a hundred or so inhabitants has grown up around the railway yards. Here coal and water are taken aboard the engines, and here cattle may be fed on their long journey as at White River. There will be a school and a church, but often enough no road has yet reached such a station. It is significant that there are small farms to supply local needs, though the soils are only third class in general. Here potatoes, oats, turnips, and other vegetables are readily grown; and the writer expects a great extension of this sort of settlement as the population-pressure from the south increases. There is often money to be made by collecting wood for the paper-mills, which form yet another asset in the region. Some very large plants have been erected on the lake shore, where it is easy to collect large rafts of pulp-wood. Finally, it is worth noting that the first transcontinental *road* in Canada was only completed in 1942, when Hearst was linked to Fort William near Longlac (Fig. 55).

The topography of the northern and western shores of Lake Superior is that general throughout the Shield. The undulating granitic surface is studded with small lakes often dammed by heaps of glacial till. The rivers are beginning to cut notches in the granite and waterfalls are universal. Some large power plants have developed, especially to the south of Lake Nipigon, where extensive deviations of former streams have greatly increased power supplies. The region is not much above 1,000 feet in elevation, with steep slopes adjacent to the big lake. Thus the river divide is quite close to Lake Superior, and is indicated in Fig. 55 by the line labelled 'Height of Land'. This term is far preferable to 'Great Dividing Range', which is used in eastern Australia for a feature which is

often no more prominent. The hythergraph for White River (Fig. 59) shows the chief rain in summer. The range of temperature is large.

The Forestry map shows that this Division is not a very satisfactory unit since the southern portions belong to the *Lake* Forests, while the northern portions, including the lake shore from Fort William to Michipicoten (Mich.), belong to the *Boreal* Forest (Fig. 40). According to Halliday the topography north of Sault St. Marie consists of east–west valleys with birch, fir, spruce, and maple on the gentle northern slopes, and white pine and cedar on the steeper southern slopes. It is possible that the deciduous trees invaded Canada across the narrow straits of Sault St. Marie (' Soo '). South of Fort William and around Lake of the Woods red and white pine with a good deal of white birch are the commonest trees, but owing to the cold climate they are rather small.

North of Lake Superior the forest belongs to the boreal division. The cold air masses from the north seem to move towards the Great Lakes across this part of Canada. There is rather a large expanse of bare rock, in part due to the frequent forest fires in the past. White spruce and balsam fir are the characteristic trees, though black spruce grows where the glacial till is somewhat thicker. Around Lake Nipigon there are considerable deposits of lake silts, and here black spruce, jack pine, and tamarack are rather abundant.

As might be expected there are valuable mineral resources in the granites of the Shield in this region. Sudbury is the most interesting mining field in Canada, not only because it supplies so much of the world's nickel, but also owing to the unique pattern of the ore deposit which is associated with a sort of ' sill ' of basic eruptive rock. This feature will be described (p. 441) in a later chapter. It has grown amazingly in population, having only 2,000 in 1901, and doubling its population every decade. In 1956 the figure was 46,000. In addition to the numerous mines in the vicinity and the smelters at Copper Cliff, there are 52 factories, largely linked with the railways and the lumber industry.

Near Michipicoten (Mìchipi-còtton) are extensive iron ore deposits, which produced 3·4 million tons between 1939 and 1944. Near Port Arthur on a tiny island called Silver Islet some 3 million dollars value of silver was obtained in the seventies. A good deal of gold has been won from many small mines north of Rainy Lake, but they have not been worked for some time. The most interesting field in this area is at Steep Rock, where very rich iron ores have been discovered in the bed of the lake. This occurrence is described later (p. 434).

The Western District around Fort William

This district does not fit in readily with any adjacent area, but may be appended to the natural region just considered. It has too little agriculture to be joined with Winnipeg and its rich agricultural plains. It has a rather specialized forest cover, as we shall see, but its importance does not depend on its climate or soil, but on the fact that it lies at the head of the Great Lake system, where cargo ships receive their loads from the rich prairie lands to the west. In the vicinity are some important ore deposits, which have increased the population somewhat; but nearly all the inhabitants live in the two adjacent ports of Fort William and Port Arthur.

Essentially this region consists of a fairly uniform section of the Canadian Shield extending from Lake Nipigon westwards to the silts of Lake Agassiz (Fig. 55). All the major formations of these very ancient rocks appear in the region. Near Nipigon the oldest rocks, consisting largely of green schists and porphyries, are assigned to the *Keewatin* series. Above these in places are found slates and limestones which have been named the *Animikie* series. Still higher beds belong to the *Keeweenawan*, and consist of conglomerates and sandstones. Near Port Arthur are numerous level intrusive sills of this age which stand out as shelves around Mt. Mackay (Fig. 56). In some areas, as near Steep Rock, there is a Lower *Huronian* series above the Keewatin; and *Algoman* granites are a little later than these, but seem to be older than the Animikie slates. Most of these formations are indicated in the section given in Fig. 57.

The Animikie contains valuable deposits of silver and iron ore, such as that found in the once famous mine on Silver Islet, 25 miles east of Fort William. The famous iron deposits of Steep Rock seem to belong to the older rocks of the Lower Huronian. A number of goldmines have been developed in the region, but none of them is of importance at present.

The topography is that normal to the Shield. The undulating peneplain has been covered with a veneer of glacial debris which has filled in some hollows, and has resulted in the incredible number of small lakes, and very irregular river drainage of the region. It is worth noting that the rivers flowing into the western lakes, and ultimately into Hudson Bay, rise only a few miles from Lake Superior to the south-west of Fort William (Fig. 55). Hence the first interest in this region was due to the presence of the famous 'Grand Portage' which is shown on the map. Later an alternative route was developed along the Kaministiquia River which flows into Lake Superior at Fort William.

Very interesting developments have taken place in connexion with the drainage of the Lake Nipigon basin. This lake is rectangular

in outline and covers about 2,800 square miles. The divide is about 15 miles north of the lake, and the north slope is drained by the Ogoki River towards Hudson Bay. The Waboose Dam across this river helps to divert its upper waters southward to Lake Nipigon. This will add 4,000 cubic feet a second to the power supplies of this large lake.

Lake of the Woods is another very interesting lake towards the west of this region. It is very irregular in outline and empties northward at Kenora into the Winnipeg River. Here was the famous ‘ Rat Portage ’ which was necessary to circumvent the rapids near the outlet. The name ‘ Kenora ’ combines this old name with Norman and Kewatin, small settlements in this area. The town has a population of about 8,700 and is a popular tourist resort. There are large hydro-electric plants, two cathedrals, flour-, lumber-, and paper-mills, and boat factories in this flourishing town right on the Shield. Many acres of oats and other grains are grown where pockets of fair soil occur, as is often the case outside of the true ‘ Clay Belt ’ (see Photo 4, p. 10).

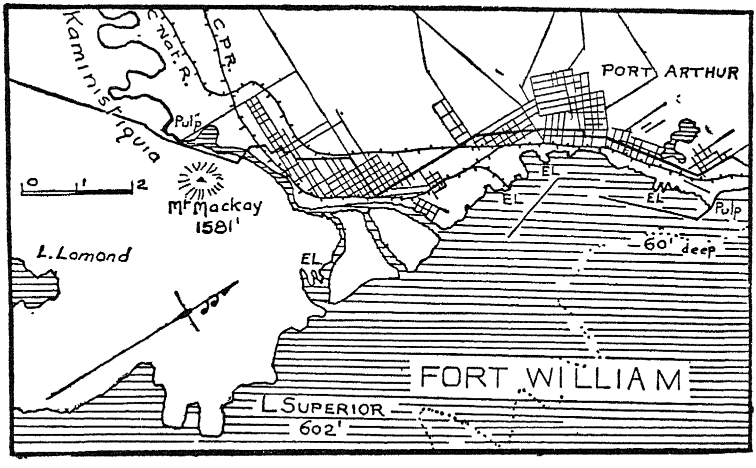


FIG. 56.—The twin cities of Fort William and Port Arthur. The chief sites of wheat elevators (El.) and pulp-mills are indicated

The main interest in this small region, however, centres in the great lake ports of Fort William and Port Arthur (Fig. 56). The former of these contains 39,000 and the latter 38,000 inhabitants. There is only a distance of 3 miles between the two ports, and the growth of Port Arthur depended in part on the lower prices of the land to the north of Fort William when many of the giant elevators were erected on the lake shores. Fort William is an old fur-trade settlement, where the boats left the lake and ascended the Kaminis-

tiquia River on their way to the interior of the Dominion. Today it is the lake terminus of the C.P.R. railway as well as of several local lines. Loch Lomond, a few miles south, is 358 feet above the town and furnishes the water-supply. There are about 40 giant elevators along the lake shore, in which the wheat and other grains are stored for shipment. About half of these are in each of the towns. Flour-mills, foundries, various factories, paper- and pulp-mills are situated here. It is worthy of note that some energetic farmers are making a success of growing potatoes and berry fruits, though the soil is not in general suited for crops.

Port Arthur has a much more striking series of giant elevators along the lake front than Fort William. It is to some extent the shipping centre, while the railways are served from Fort William. Shipbuilding and a large dry dock characterize the town. There are factories of the same type as in Fort William. The important iron deposits 100 miles to the west near Steep Rock are described later (p. 433).

A few notes on the forest cover may close this short section. Red and white pine are the most abundant trees, and Halliday states that large areas of them still remain. Balsam fir and basswood are more common near the U.S. boundary, where also some white elm and sugar maple are to be found. All the trees tend to be smaller here than their relatives growing to the east of the Great Lakes region.

CHAPTER VII

THE PRAIRIE REGIONS

NATURAL REGION 5: WINNIPEG BASIN

SOUTHERN Manitoba, which consists essentially of the lowlands around Lake Winnipeg, is a very interesting region of the Dominion, especially as regards structure. Here the Canadian Shield is covered in part by Paleozoic formations, as we have seen in the eastern regions already described. But here for the first time we meet with extensive Mesozoic and Tertiary formations, which are lacking in the eastern provinces. For this reason some little time may be given to a consideration of the main geological features in the vicinity of Winnipeg. The account is based on a graphic description given by R. C. Wallace, *Geological Formations of Manitoba*, Winnipeg, 1925. I cannot do better than quote his summary.

There are four main time intervals in the geological history of Manitoba, during which contributions have been made to the rocks now to be found in the province. The first is out of all proportion the longest in time value: the Pre-Cambrian. It involves a complicated sequence of volcanic activity, sedimentation, mountain-building, and denudation on a vast scale—it may be, not once but twice, with the final planing down of high relief to a peneplain with but few elevations left. The rocks, both igneous and sedimentary, have been considerably metamorphosed by the intense pressure reactions during the period of mountain-building. Since then there has been a continuous period of quiet sedimentation and of elevation and erosion.

Some 400 million years ago, in the Ordovician Age, this part of Canada sank beneath the sea. In the rather deep, clear seas were deposited sediments rich in lime and magnesium, and containing fossils of Ordovician, Silurian, and Devonian types. The area was now elevated above sea level until the end of Lower Cretaceous times, say about 50 million years ago. Now the Western Plains as a whole were covered with muddy oceans or inland lakes in which great thicknesses of shales and sandstones were laid down. This deposition continued into Eocene times when the land was elevated again, and since that time the soft Eocene shales have been much eroded by wind and weather.

The last stage in deposition was the result of the southward progress of the ice-sheets of Pleistocene times. As a result of their erosive activity,

there have been deposited on the surface of the older rocks boulders and eskers, moraines, drumlins, and glacial till; while in the great glacial lake (Lake Agassiz), which formed on the southward margin of the retreating ice-sheet, bedded clays were deposited; and beaches were formed along the margin of the lake during the successive halts in the lowering of the lake surface. In Recent times rivers have cut their ways through the glacial clays, lakes have to some extent been silted up, and extensive peat bogs have been formed on the surface of the glacial deposits. The topography of the country has on the whole been only slightly modified since glacial times (Wallace).

A vertical section across the south-east of Manitoba appears in Fig. 57, and gives the clue to the stratigraphy of much of the Dominion. The great Canadian Shield has a very complex structure, but the essentials appear in the section. According to Lawson the oldest formation is an extensive series of greenstones (altered lavas, &c.) to which in 1885 he gave the name *Keewatin.* After a long period of erosion a second great series of conglomerates, quartzites, and slates was laid down which are called the *Huronian* Sediments. Both of these at a later date were intruded by enormous masses of granite known as the *Algoman* series. Some hematite deposits are associated with the older Keewatin Series, but the gold, copper, lead, and zinc ores seem to be due to vapours and solutions introduced into the surrounding rocks during the igneous activity of the Algoman.

The Paleozoic rocks near Winnipeg occupy a zone about 100

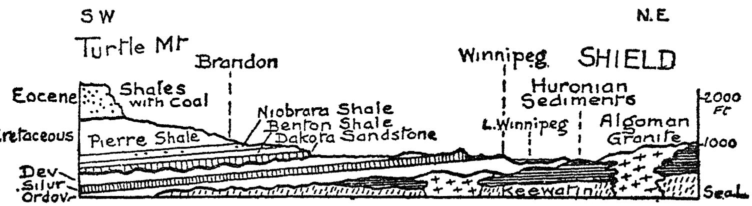


FIG. 57.—Geological section across the south-east corner of Manitoba

miles wide between the Shield and the Cretaceous Cuesta (Fig. 57). The Ordovician beds of limestone are about 500 feet thick in places, and of these the Upper Mottled Limestone furnishes a good stone for public buildings, much used in Winnipeg. The Silurian beds form a series about 300 feet thick, of which the central beds contain deposits of gypsum up to 150 feet thick. These are quarried at Gypsumville at the north-east corner of Lake Manitoba. The Devonian beds cover a rather broader belt of Manitoba, and the Devonian limestones and shales (as in southern Ontario) seem to be somewhat less resistant than the other two. At any rate, the

large lakes of Manitoba and Winnipegosis have been eroded in this series to the west of the Silurian formation. The limestone is used for cement, and there are many brine springs just to the west of the two lakes mentioned.

The Upper Cretaceous beds in Manitoba are much thicker. The rather hard Dakota Sandstones are about 200 feet thick, and lie at the base of the series. They are of some importance as a source of artesian waters. The Benton Shale contains some indications of oil which are more noticeable in the Niobrara Shales above them. The Pierre Shales are 1,000 feet thick in places, and are used in brickmaking. The rather steep eastern faces of the Pierre formation build up much of the Cretaceous Cuesta, which is such a prominent feature in Fig. 57. The three main 'mesas' are called Riding, Duck, and Porcupine Mountains. They rise about 1,500 feet above lake levels, which lie between 700 and 810 feet above the sea (Fig 60).

Only in the extreme south do Tertiary beds occur, i.e. at Turtle Mountain (Fig. 57), but they are much more extensive in Saskatchewan. There seem to be about 800 feet of Eocene beds, chiefly shales and clays which contain a good deal of lignite. There are various coal seams, the largest being 7 feet thick. Dowling has estimated 160 million tons in this area, but it has not been used except by local farmers. At Estevan in the next province it is exploited much more.

The present-day landscape is of course mainly determined by the cover of glacial debris, or fluvio-glacial material, left by the ice-sheets of the Pleistocene. The ice moved for the most part from the north-east, though it has been suggested from the drumlins in Lake Winnipeg, that this region was between two major ice-lobes. According to Tyrrell, the first ice moved from Keewatin, i.e. in the north; and was followed by ice from a centre north of Lake Superior. There is evidence of several ice ages, but not many data suggesting the character of the interglacial periods.

A great moraine—the Itasca Moraine—extended to the north-west through Brandon, and for a time dammed Lake Souris to the west. (This lake is suggested by the line of dots marked 'L.S.' in Fig. 58.) Later another similar moraine shut off to the east of the town a lake called Lake Brandon, whose boundary is also indicated by dots in Fig. 58. The greatest of these glacial lakes was Lake Agassiz, whose limits are indicated in the same map. This was held up for many centuries by the ice-sheet, which halted at some such position as suggested in Fig. 58. As a result, the whole area of 110,000 square miles was more or less covered by a layer of fine lake silt. Near Winnipeg these lake silts are about 10 feet thick, but are covered by about 6 feet of sandy material probably brought

down later by the Red River. To the north of Winnipeg the silts are about 50 feet deep.

The lake drained at first to the south through the Traverse Gate mentioned on page 48. The next outlet was probably by

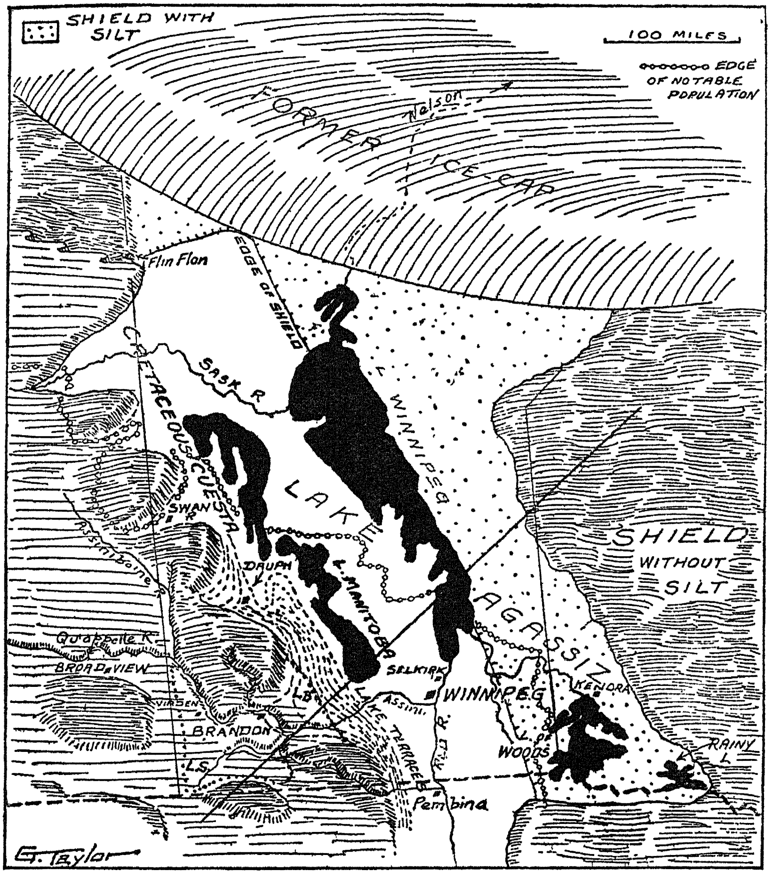


FIG. 58.—The topography of Manitoba showing Glacial-Lake Agassiz. The hypothetical position of the Ice Dam is indicated. The edge of the Shield is shown, but is sparsely covered by lake-silts in the east (shown by dots). Glacial-Lakes Souris and Brandon are shown by L.S. and L.B. The line of section in Fig. 57 is given

way of the Hayes River, while today the waters reach the sea by the Nelson River. This huge lake is marked on the west shore by 27 beaches, cut out by the waters at varying levels. Upham states that 18 of these were formed when the lake drained to the south, while nine of them developed after the flow was to the north.

'Aboriginal man came late in this area, but he worked and played on the shores of Lake Agassiz, as that lake gradually sank to its present dimensions' (Wallace).

The present drainage is naturally in a very immature condition, and has been determined chiefly by the glacial conditions. The lines of moraines and eskers, &c., run mostly north-west to south-east, accounting for the higher portions of much of the swampy landscape. The ice often scraped out the softer schistose portions of the Shield, and left the harder granites as ridges. These elevations also had much the same direction, and form some of the promontories obvious along the shores of the three big lakes (Fig. 58). Wallace thinks that the cliffs fringing the lakes were in part due to ice-plucking of the Paleozoic formations, but also in part result from normal erosion.

Climate and Vegetation of the Winnipeg Region

The main features of the climate have been mentioned earlier. The outstanding fact is the 'continental' character. Winnipeg

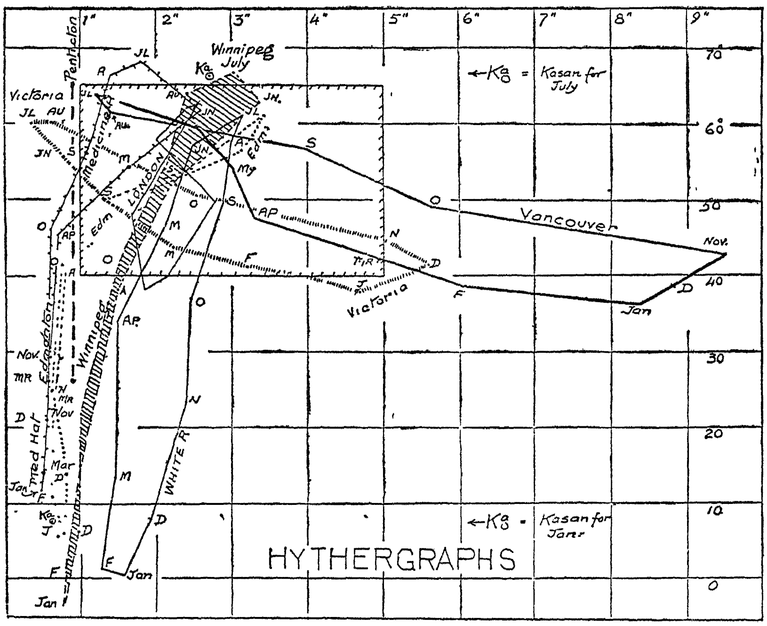


FIG. 59.—Hythergraphs for central Canada. They are twelve-sided graphs, where each angle represents the temperature-rainfall data for one month. The rectangular 'Comfort Frame' at the top includes the climatic features which the author considers the most comfortable. 'Ka' shows the ends of the hythergraph for Kasan in Russia (for comparison)

varies from $-4°$ F. in January to 66° F. in July, a range of 70 degrees. This is approaching the maximum for Canada, which is found on the lower Mackenzie and amounts to 81° F. The main features of the climate are indicated by the hythergraph for the city given in Fig. 59. Here the great range is suggested by the length of the vertical axis of the hythergraph. The attenuated shape, of course, means that there is very little difference between the spring and autumn conditions, though June is the wettest month with about 3½ inches. The average frost-free period is about 105 days at Winnipeg, but practically any place in the prairie region may be hit by frost in any month of the year, not excluding July. The region is unusually free from cloudy days, sharing with Saskatchewan and central northern Canada in this abundance of sunshine. The snowfall of 50 inches is low, but is greater than in southern Saskatchewan.

Homoclimes of this region are to be found only in U.S.S.R. in the plains each side of the Urals. In Fig. 59 the July and January positions for a hythergraph of Kasan on the Volga are given, and it will be seen that these extreme points agree fairly well with those for Winnipeg. Köppen makes his well-known 'Dfc' region extend right across the Dominion from Alaska to Newfoundland, which includes altogether too much climatic variation to be very helpful in a study of homoclimes. However, the middle Volga and the southern Obi basins perhaps come nearest to the Winnipeg region. If we adopt the criteria suggested by the 'comfort frame' in Fig. 59 then it is clear that the region has seven or eight months which are below 40° F., and therefore too cold for crops or comfort. It must of course be acknowledged that most Canadians enjoy the clear cold weather of winter months, and many prefer this type of weather to the milder more humid conditions of a marine climate.

Winnipeg lies in the transition zone between several important vegetation belts. In the south-east corner of the region Halliday places the limit of the 'Lake' Forests. Here, around Rainy Lake, the Shield is covered with a veneer of glacial deposits with some lake silts. Thus swamps with eastern white cedar are very common, while balsam poplar, white spruce, and balsam fir are abundant, and in favoured areas near the rivers are maples and oaks.

The commonest forest types, however, belong to the boreal division; but there is evidence of a constant struggle between the grasslands and the forest here. The higher areas south-west of Winnipeg city are definitely grasslands, but these grade into Halliday's 'Aspen-Oak' section. Aspen mixed with black poplar is the commonest association. Bur oak is found most abundantly on the Cretaceous Cuesta, but spreads into the flood plains. When the ice-sheet moved north it left behind relics of the northern forests

in the shape of white birch, Balm of Gilead (*Populus*), and white spruce. These 'relic' trees occur on Turtle and Pembina Mountains. The soils change from a chernozem to podsol as we move from grasslands to northern forest.

A reference to Fig. 58 will show that all the important population in Manitoba is found in this southern region around Winnipeg. Settlement has spread all around Lake Manitoba, but hardly touches the shores of Lake Winnipegosis or Lake Winnipeg. The shallow depth of the lake silts accounts for the absence of many farms on the eastern margin, but the reason why settlement does not progress faster north of Lake Manitoba is not obvious. I have not visited this area, but Professor Innis tells me that drainage conditions are difficult, and there seem to be large areas of glacial erratics which cover the lake silts.

The region contains only two large towns, Winnipeg and Brandon. Winnipeg is the fourth city in the Dominion, with 253,000 inhabitants in 1956. It is 100,000 less than Vancouver, and about half that number ahead of Hamilton, Ontario. In 1871 there were only 241 people in the little settlement, so that it made very rapid growth during the first three decades of this century. It is situated at the confluence of the Red River and the Assiniboine, which have cut down about 20 feet into the level flood-plain near the city. It is a very important railway centre, with a position somewhat like that of Chicago, i.e. where all the railways bend to the north-west round the south of a large lake. The rich silts of Lake Agassiz have made it one of the chief agricultural districts of the Empire, and its grain market is accordingly one of the largest in the world.

The next largest town is forty-sixth in the Dominion, so that Brandon with a population of 20,600 is a long way behind Winnipeg. It has grown up on the banks of the Assiniboine about 134 miles west of Winnipeg. Its chief interest is in grain, but cattle and hogs are reared. Portage la Prairie, about half-way between the other two larger towns, has about 10,000 inhabitants. It has much the same interests, but bricks and cement are made here. It is somewhat of a summer resort owing to the woods in the vicinity. Selkirk is 22 miles north of Winnipeg, and is the head of navigation on the Red River. It handles the fish caught in the big lake to the north, and has a population of 6,200. Dauphin is about the same size, and has grown up at the foot of the great cuesta to the west of Lake Manitoba (Fig. 59). It is a centre for wheat, cattle, and poultry. The interesting lake-beaches, dating back to glacial times, are especially well developed at Ethelbert and Pine River along the railway to the north of Dauphin. Neepawa and Minnedosa are two little towns to the north of Brandon with populations around 2,000.

NATURAL REGION 6: THE WESTERN PRAIRIE

This region is fairly well marked off from its neighbours in several respects (Fig. 60). It is essentially the Grassland region of Canada, which suggests that the climatic controls are rather well marked. Here, indeed, is a region with marked summer rain of a rather light character, and with some six months in the year receiving a good deal of solar energy. As explained on page 106, this leads to the growth of prairie grasses rather than of coniferous forests.

As regards topography the region is a good deal higher than the last region, though that also belongs to the Prairie Provinces. Most of our present region is over 2,000 feet above sea level, and a fairly definite cuesta crosses the eastern portion of the region, which received the name of 'Missouri Coteau' from the early French trappers (Fig. 60). (This word *coteau* is of course the French form of cuesta, which is a Spanish word for a scarp.) But three large widely spaced 'outliers' of this elevated area lie to the north-west and east of Regina, and these are really parts of the same low plateau which have been isolated by river and glacial erosion. (Photo, p. 176.)

The build of the whole Prairie region is fairly simple, for the Tertiary and Cretaceous rocks lie in relatively horizontal strata, and have not been much affected by folding until the Rocky Mountains are approached. Early Tertiary beds build up much of the higher lands near the southern border and form the Cypress Hills and Wood Mountain (see section at front of Fig. 60). These rest upon the very widespread Pierre formation which is Upper Cretaceous, and extends from the Cretaceous Cuesta (Duck Mt.) in the east as far as a north–south line through Edmonton, Drumheller, and Lethbridge. However, the South Saskatchewan River seems to have cut out a broad curved belt of this formation and exposed the underlying Belly River series (shown within the dotted line in Fig. 60) from Lethbridge to Medicine Hat, and it is also the surface rock north to Wainwright. Along the slopes of the Rockies is a belt of the Edmonton series (right at the base of the Tertiary), and much of this formation is in turn hidden by a wide layer of the later Paskapoo Series. The latter is the surface rock at Macleod, Calgary, and Red Deer, and in the district east of Edson.

In southern Saskatchewan the highest points are found in the Tertiary Hills which rise almost to 4,000 feet at their western end. These hills are carved into long deep coulees (gullies), and are grass-covered for the most part, though in the drier areas there is a development of 'badlands'. The Missouri Coteau is somewhat of a ridge with a steep eastern scarp, and is about 2,500 feet high. It has a gentle slope to the west, below which are salty lakes.

The South Saskatchewan River in this province occupies a valley

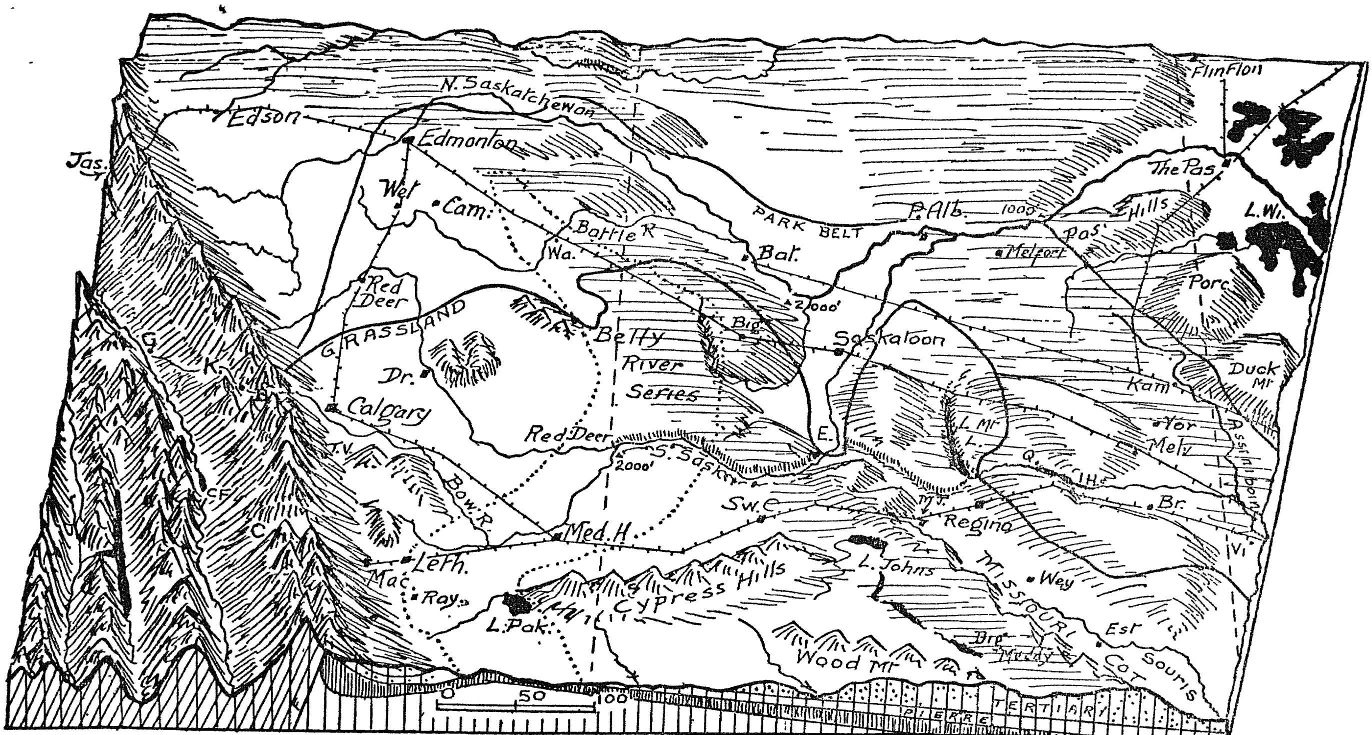


FIG. 60.—Block Diagram of the Western Prairies. The border of the Grassland and the boundary of the Belly River Series are shown. A geological section appears at the front edge. (Based on a model by D. B. Dowling)

PHOTO 5.—SASKATCHEWAN RIVER NEAR RIVERSIDE ON THE PRAIRIES (p. 9)

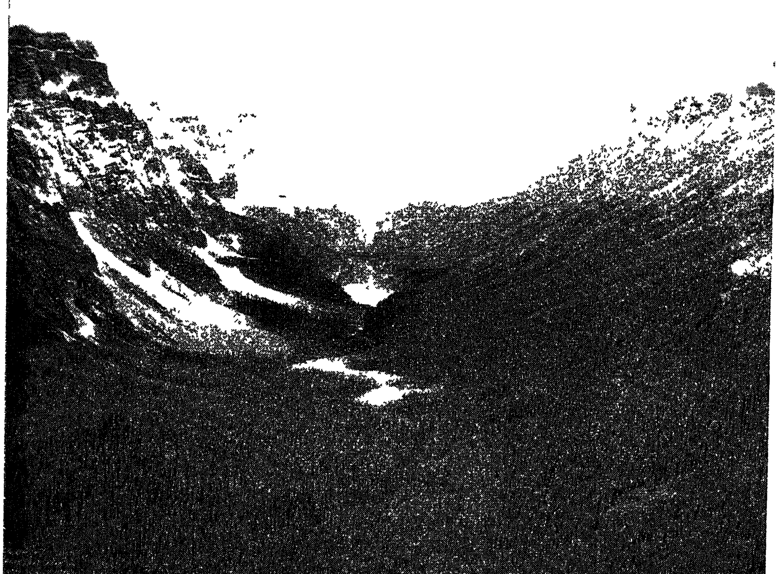


PHOTO 6.—GLACIAL VALLEY IN THE ROCKIES SOUTH-WEST OF BANFF (p. 9)

about 2 miles wide. The banks are mostly from 200 to 300 feet high, but where the river passes through the Coteau they are 500 or more feet high, giving rise to rather fine scenery. Below the Elbow (E. in Fig. 60) the banks become lower, and oxbow lakes fringe the river. In the arid south there are relics of former large rivers, as for instance the series of elongated 'lakes' linking Lake Johnstone to Big Muddy Lake (Photo 5). Most of these lakes are dry or contain alkaline waters. Last Mountain Lake is about 50 miles long, and lies to the north of Regina. It is about 100 feet deep, and is fresh since it drains into the Qu'Appelle valley. Near here is the long dry valley connecting the south end of this lake with Elbow on the South Saskatchewan River. There seems little doubt that these elongated lakes and dry valleys are the relics of a very important glacial drainage system, which was in operation at the front of the former ice-lobes when they covered this region at the end of the Ice Age (Memoir 176, *Geol. Survey*, 1935).

West of the Missouri Coteau the plateau rises to the foothills near Calgary, with some marked depressions such as the valley of the South Saskatchewan River at Medicine Hat. The surface is quite irregular and the topography quite varied, contrary to the impression which so many people, unfamiliar with the western plains, have regarding this region. The average elevation is about 2,300 feet above sea level, with prominent flat-topped eminences such as the Cypress Hills eroded in the Tertiary strata. The Cretaceous Plateau passes westward into the *foothills* of the Rocky Mountains, and here the folding and faulting which produced this mighty range begin to be evident.

The flat hills, remnants of the plateau farther east, give place to irregular and rounded knobs, the result of erosional agencies playing on twisted and broken strata. Deep ravines are cut in great thicknesses of gravel and other debris washed down from the peaks to the west. The foothills run up to 5,000 feet above sea level, and grade into the Cordilleran province (E. S. Moore, *Mineral Resources*, 1929).

Climate, Vegetation, and Towns of the Western Prairies

In the interior of a large continent there is not much variation in the climate, provided that the topography, as in the section under discussion, is relatively uniform. The temperatures are normal for the latitude, and do not differ much from those in the Winnipeg area. The region around Lethbridge and Calgary, however, is already experiencing some slight benefit from the warm waters of the Pacific, for the range of temperature here is about 14° F. less than in the Winnipeg district.

Around Medicine Hat is one of the driest districts in Canada, for the total rainfall is only 12·75 inches; but the general character

of the rainfall does not vary much in the whole prairie section. Hythergraphs are given for Edmonton and Winnipeg (Fig. 59), which are on the borders of the region under discussion, and for Medicine Hat right in the middle of it. The 'bulges' in the graphs towards the top right corner suggest that there is some slight approximation to a 'monsoon' rainfall in all three places, since it is largely confined to the warm summer months. It will be noticed that Edmonton is wetter than Medicine Hat in every month of the year.

The homoclimes for this region are much the same as for Winnipeg. Since the range of temperature is smaller, the Russian homoclimes will be found in the west of that country, say in the vicinity of Moscow or Kasan (Fig. 59), rather than in Siberia. The snowfall is rather light, but is very variable from year to year. Thus Koeppe states that Medicine Hat 'in one October received over two feet of snow, although the average is only one inch; in fact almost as much came in that one month as is normally received in a whole year'. The Chinook winds have been described in an earlier chapter, and are very important in this region. Stupart writes of Alberta as follows:

> The normal winter is cold and in some years extreme cold is continuous from November to March, but in other years the Chinook wind is most persistent, and warm days with bright sunshine are the characteristic features of the winter. The mean temperature of November 1890 at Calgary was 39° F., but the mean of November 1896 was 2° F.; the mean of January 1906 was − 6° F., while in the following year with numerous Chinooks it was 26° F. In April the temperatures are as high as 53° at Calgary and Edmonton, which indicates very clearly that April is very truly a spring month. In July the average mean maxima are 82° F. at Medicine Hat, 75° at Calgary and 73° at Edmonton; but these high temperatures are accompanied by pleasantly cool nights. In summer the isotherms run almost north–south, hence the mean summer temperature is almost as high in the extreme north as in the south. Owing to the Chinook southern Alberta is usually bare of snow during the greater part of the winter.

The driest portion of the great prairie region is described by F. E. Lloyd as the northernmost extension of the belt of deserts which reaches continuously through the west centre of the continent from Mexico. The great grassy prairies to the east of the Rockies were the home of the American bison, treeless save for 'poplar bluffs', clothed with crisp nourishing grasses, and adorned with numberless flowers in their season.

West of the Missouri Coteau the rather arid country is the habitat of the cactus *Opuntia* which is a northern outlier of the southern deserts. Trees are smaller here than in the wetter lands to the east; and soon, as we proceed west, only the poplar and

scrubby oak survive. The groves along the streams are known as 'poplar bluffs' and are a feature of the semi-arid plains. Shrubs make low thickety growths of stunted plants. *Shepherdia* (buffalo berry) and *Eleagnus* (silverberry) are typical arid plants.

Near Moosejaw short wiry xerophilous grasses, such as *Grama* and buffalo grass, are abundant, while *Artemisia* (sagebrush) occurs in the more rocky places. The higher sandy areas produce a characteristic plant cover of which the following are some of the most abundant genera: *Potentilla*, *Selaginella*, *Pulsatilla*, *Solanum*, and Aster. The salty lake area is characterized by *Atriplex*, *Chenopodium*, *Salicornia*, *Salsola*, *Rumex*, and *Ranunculus*. The foothills of Alberta carry taller grasses and pasture plants such as *Festuca ovina*, *Danthonia intermedia* as well as *Astragalus*, *Vicia*, and other *Leguminosae*.

To the north of the true grassland belt, but more akin to it than to the coniferous forest (Taiga) to the north, is the Park Belt. It is shown on Fig. 60 as extending from Edmonton eastwards to the Assiniboine River, and is about 120 miles wide on the average. Mackintosh describes it in his valuable book *Prairie Settlement* as a fertile grassland dotted with so-called bluffs and patches of woodland. These bluffs vary from a few square rods to several acres, and may occupy a piece of rough land or a depression. Here the precipitation varies from 14 to 20 inches, i.e. it is distinctly wetter than the grasslands to the south. Various species of poplar with some maple and ash are the chief trees. The native grasses are of the tall prairie grass type.

The very dark brown soils of the Park Belt are distinguished not only by the darkness of the surface soil, but by their depth, ranging from 10 to 15 inches. These soils are among the most fertile in the whole region. The decaying roots of the grasses have added large quantities of humus to the soil; while the absence of much moisture between the surface and the water-table prevents the leaching of the mineral salts. There are said to be about 20 million acres of satisfactory arable lands in the Park Belt, and it is predominantly a wheat-growing region.

The Park Belt is also an important area for stock-raising, especially in the Alberta section where humidity is a little higher than in Saskatchewan. The farms are usually smaller than in the open prairie, a half-section (320 acres) being a very general size. Except for the Red River valley (in Manitoba) it is the most densely inhabited area of the Prairies, and this is a little surprising because the railway reached this area much later than it did the drier southern grasslands. This fact merely emphasizes the importance of the environment; for the northern Park Belt soon passed the grassland in importance when equal transport was available to both.

The Western Prairies are today studded with large and small towns, all of which have developed in the last sixty years or less. The following table shows the more important of these in the two provinces of Alberta and Saskatchewan with their populations in 1956:

Alberta		Saskatchewan	
Edmonton	226,000	Regina	89,000
Calgary	181,000	Saskatoon	73,000
Lethbridge	23,000	Moose Jaw	30,000
Medicine Hat	21,000	Prince Albert	20,000
Red Deer	12,000	Weyburn	8,000
Drumheller	2,600	Swift Current	10,600
Camrose	5,800	Yorkton	8,200
Wetaskiwin	4,400	N. Battleford	8,900
Raymond	2,300	Melville	4,900
		Estevan	5,200
		Melfort	3,300

A glance at Fig. 60 shows us that the largest city, Edmonton, has grown up farther north than any of the others. Its choice as capital of the province no doubt in part accounts for this pre-eminence, but it is largely due to the fact that the better rainfall lies along the northern edge of the main settled area. Edmonton is a great 'port of entry' for the north-west of the Dominion, and the most progressive portion of the new lands in recent years have been the Peace River farms to the north-west of Edmonton.

Edmonton is served by the two main lines, and is the southern terminus of two smaller railways. It has grown up mainly on the northern bank of the North Saskatchewan River, which here flows in a deep valley about 150 feet below the city. Fort Edmonton was established as far back as 1795 on a site now occupied by the capitol. There is one of the largest airports in Canada a few miles out of the city, which is in constant touch with the mining and oil fields of the north. Wheat and oats are very largely grown in the vicinity, and there is a good deal of dairying. There are coal deposits worked on a small scale in the vicinity, and it is the centre of a considerable tourist traffic, since it lies half-way between Jasper on the west and the Wainwright Buffalo Park on the east. Leduc oil field is nearby.

Calgary lies almost 200 miles to the south of Edmonton, but there is very little difference in the climate. The southern city has an inch less rain in the year, while its average temperature is about a degree higher. It is situated on the Bow River, whose western bank rises high above the city, while behind it is a distant view of the snow-covered Rockies. It is on the direct route by

the Canadian Pacific Railway to the west via Banff and the Kicking Horse Pass, and so is visited by thousands of tourists. Calgary is the trading centre of a great stock-raising and agricultural area. There is some irrigation in the vicinity, and over 100 small factories have developed in the city. These include flour-mills, breweries, oil refineries, and many woodworking and engineering shops.

To the south of Calgary is the Turner Valley oil field, but Leduc, 180 miles north, is now the chief source in Canada. Alberta was producing over a million barrels in 1936, and this rose to 77 million barrels in 1953. Camrose, Wetaskiwin, and Red Deer are small towns between the two large cities, chiefly interested in grain, though there are supplies of coal near each. Drumheller to the east of Calgary is the chief coal producer in the province, and as in the case of Lethbridge and Blairmore to the south, a number of factories have already developed as a result of the abundance of coal. (A more detailed description of this important coalfield will be found on page 424.) Raymond in the far south is in the stock-rearing region, and a good deal of sugar beet is grown with the aid of irrigation. Medicine Hat in the south-east of the province has large supplies of natural gas. Wheat and cattle are the chief interest in this rather arid part of Canada.

In Saskatchewan there are no cities as large as Edmonton and Calgary, but there is a considerable number of intermediate towns with around 5,000 inhabitants, which are quite lacking in Alberta. In this province there are two rivals for pride of place, Regina and Saskatoon, the former being situated in the grasslands and the northern city in the Park Belt (Fig. 60). In 1882, Regina was a small hamlet of but a few hundred people who had come west to start a settlement in what was then a bare stretch of prairie. Today it ranks as the fourteenth city of the Dominion with a population of 89,000. It is the capital of the province; and the Legislative Buildings overlook Lake Wascana, a considerable artificial expanse of water which is surrounded by parks. It is the western home of the Canadian Mounted Police, but the University of the province is in Saskatoon. There are nearly a hundred factories, connected with printing, oil refining, machinery, food, wood, and animal products; and it is said to be almost the largest distributing centre for farm machinery in the world.

Saskatoon lies 140 miles to the north-west of the capital on the South Saskatchewan River. The University and residential districts are on the east bank, and the main shopping and industrial centre on the west bank. It has grown from a population of 113 in 1903 to one of 73,000 in about fifty years, due essentially to its position in the centre of the well-watered Park Belt. It is the trade centre for 70,000 square miles, and is surrounded by the greatest

wheat-growing area in the Empire. Very prominent are the huge mills and grain elevators of the Quaker Oats Company and the Robin Hood Flour Company. In the future it may be the storage centre for wheat going to Europe by the new Churchill–Hudson Bay route. There are a number of factories connected with agriculture, machinery, brick quarries, brewing, &c.

Moose Jaw is 40 miles west of Regina and is the centre of a rich farming district, and the gateway to the rather arid ranching districts amid the Tertiary hills to the south. Wheat is the dominant product, but it has the largest stockyards west of Winnipeg. Prince Albert was first settled by Indian half-breeds about 1870 after the rebellion of that period. It is the gateway into the forests of the north, and many traders, trappers, and miners get their supplies here. It is also a great fish and fur market, while many wood-working and lumber industries have developed in Prince Albert. Weyburn, to the south-east of Regina, is on the road to the Souris River district, where wheat, cattle, and hogs are the chief resources. Estevan, further to the south-east, is the centre of the lignite mining of the province. There is a large briquetting plant, and electric power based on the lignite supplies nearby factories. Good clay for brickmaking is found near Estevan. Of the remaining small towns only Swift Current, on the main Canadian Pacific Railway, is in the south; all the others, Yorkton, Battleford, Melville, and Melfort are in the Park Belt. Since these places have slightly cooler climates than the southern centres it is clear that the heavier rainfall of the north is of even greater value to the new settlers.

CHAPTER VIII

SOUTHERN BRITISH COLUMBIA

TOPOGRAPHY OF BRITISH COLUMBIA AS A WHOLE

THE next three natural regions are all in British Columbia, and it will be convenient to present the general environment of the three in one discussion, leaving the human responses to be described separately in the following three sections : Vancouver in the south-west, Selkirk in the south-east, and Fraser in the north centre of this part of Canada. All three are marked by the complicated structure which naturally exists in a region of rather late mountain-building (p. 45), but the rainfall, vegetation, and crops, &c., vary quite noticeably in the three subdivisions mentioned above.

Few regions in North America offer more of interest to the geographer than British Columbia. Here is an area of 359,279 square miles which has been settled for nearly 150 years, yet its total croplands of half a million acres are only about the same as those of tiny Prince Edward Island with less than 1 per cent of its area. The first real settlement was in the extreme north-east of the province, yet today 70 per cent of the population is to be found in the extreme south-west within 75 miles of Vancouver, the largest town. The chief traffic is naturally with the other settled portions of the Dominion, i.e. in an east–west direction. The 'grain' of the country, and very well marked it is, runs north–south, thus adding enormously to the difficulty of communications in the province.

In no part of America is there so rapid a change in precipitation as in the vicinity of Vancouver. Near Squamish the rainfall is said to exceed 150 inches, while 100 miles to the east at Ashcroft it is less than 7 inches. Every environment of cool temperate lands is illustrated in the province ; from the dense forests of Douglas fir on the coast—said to be the best timber left in North America—to the sagebrush and cactus flora so common in the interior ; from the extensive flats of the Fraser Delta to the large snowfields and mountain glaciers of the Rockies between Jasper and Banff.

Although little of a general geographical nature has been published about the province, there have been many geological studies, such as those of recent years by S. J. Schofield ; and the writer has based this section largely upon the conclusions of the latter.[1] In

[1] Fifth Pacific Science Congress, 1933 ; *Guidebook No. 3*, Vancouver, 1933.

Pre-Cambrian times (Beltian) the region entered a period of sedimentation in a vast basin, which continued through Paleozoic times. This early geo-syncline is suggested in the lower diagram in Fig. 61 by the vast deposits of Pre-Cambrian sediments. Later a much wider basin developed, especially in the east; and this received Carboniferous and Mesozoic deposits. These are shown as the upper layers in the diagram labelled ‘ Upper Triassic ’.

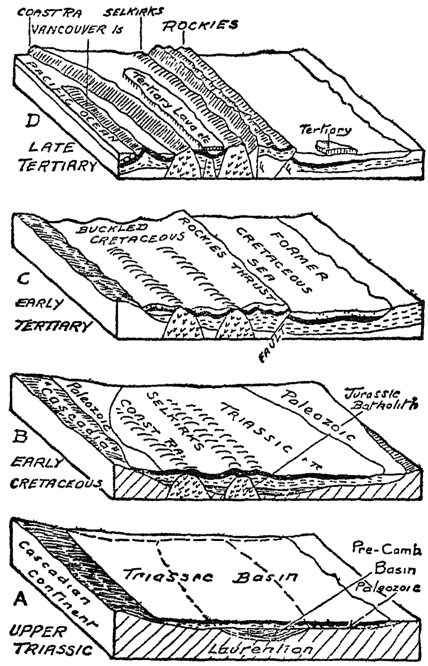


FIG. 61.—Block diagrams illustrating the structural evolution of British Columbia. Note the rise of the Rockies and the sinking of ‘ Cascadia ’ in early Tertiary times. (Partly after S. J. Schofield)

Next there occurred a major period of mountain-building, probably during Jurassic times, which was accompanied by the intrusion of vast batholiths of granodiorite. In early Cretaceous times the structure of the province looked something like that sketched in Fig. 61 for that period. We notice that a large continental area ‘ Cascadia ’ occupied the western littoral of the province at that time, and formed the western shore of the various geo-synclines. It is of interest, especially in regard to ore deposits, that the eastern areas were almost free from igneous activity, while the western were repeatedly affected by intrusions of one sort or another. A period of heavy sedimentation occurred in Cretaceous times.

The Selkirk and Coastal Ranges really date from the Jurassic mountain-building, while the Rocky Mountains to the east did not develop until the Laramide Revolution at the end of Cretaceous times. The elevation of the Rockies is suggested in the diagram dated 'Early Tertiary'. During this folding the older rocks were in places overthrust over the Cretaceous rocks. This is well shown at Crow's Nest Mountain just to the east of the pass of that name (Fig. 65), where a magnificent *Klippen* (mountain without roots) of horizontal Devonian strata is found superimposed on the much younger Cretaceous base of the mountain. The eastern face of the Rockies rises quite sharply from the foothills along this fault to the west of the prairies (see Photo 6, facing p. 176).

The later history of British Columbia is by no means easy to interpret. Many river valleys were eroded during the Eocene and were the ancestors of the rivers of today. In Miocene times immense areas of lava poured out in the lower region between the two zones of mountains. Moreover, epeirogenic movements amounting to several thousand feet affected most of the province at various periods in Post-Eocene times. During these movements 'Cascadia' vanished, and Vancouver Island consists partly of uplifted and folded Cretaceous rocks. The Pliocene was a time of great dissection which removed much of the lava. Probably this lava was originally continuous with the similar sheets to the south in the United States.

No country in the world, which has been visited by the writer, offers such complex problems in glacial topography. The landscape was sufficiently diversified before the Pleistocene, and the combination of ice-caps, valley glaciers, numerous fold-troughs, contemporary crustal movements, deep lakes, heavy rainfall followed by an arid cycle, means that many years must elapse before we can interpret the landscape adequately.

Near Revelstoke the ice was over 9,000 feet thick, and in the Okanagan at least 6,000 feet.

Strong ice currents flowed down the longitudinal valleys and also down the main transverse valleys. The smaller transverse valleys were bridged with stagnant ice over which the main ice mass flowed. It truncated peaks and ridges, giving the country a deceptive plateau-like appearance. The tops of the ridges became exposed before the lower slopes, and on account of their elevations are in a zone of very intense frost action and weathering. They have lost all trace of glaciation, and are in strong contrast to the rounded lower slopes (Schofield, *loc. cit.*).

The outstanding feature in almost all the valleys is the system of terraces cut in the post-glacial sands and silts. It is not too much of an exaggeration to say that almost all the settlement in the interior of the province is affected by these terraces. Some examples will be illustrated in the succeeding diagrams and maps.

Topographic Divisions

There are five fairly well-defined topographic divisions in the province, which depend on the developments briefly described above. Four of these are summarized in the following table:

GENERALIZED TABLE OF TOPOGRAPHIC DIVISIONS

Division	Elevation	Geology	Topography	Settlement
1. Coastal Ranges (Regions 7 and 14)	Largely above 5,000 ft.	Largely Jurassic granodiorite	Deep fiords and glaciated valleys	Almost empty
2. Interior Uplands (Region 9)	Around 3,500 ft.	Mesozoic and Tertiary shales, &c., lavas	Relatively level, arid	Grazing, farms in lower valleys
3. Selkirk Ranges (Region 8)	Largely above 5,000 ft.	Jurassic granodiorites	High ranges and wide trenches	Almost empty
4. Rockies (linked to Region 8)	*do.*	Much Pre-Cambrian, no eruptives	*do.*	*do.*

The highest mountain in British Columbia is not in the Rockies but in the Coastal Ranges. Here, 170 miles north-west of Vancouver, is Mt. Waddington (13,260 feet), which is considerably higher than Mt. Robson (12,972) near the Yellowhead Pass. These peaks and most of the other main features of the topography are sketched in the block diagram forming Fig. 62 in which we are supposed to be looking to the north-east.

In the foreground is the Fiord Coast, fringed by various large and small islands.[1] Vancouver Island contains some mountains as high as 7,000 feet. It has large farming settlements in the south and east. There are a few mines and paper-mills along the mainland coast, such as at Ocean Falls and Powell River. But only near Bellacoola behind Ocean Falls is there any farming. Some Indian villages are to be found in the interior. No road crosses this mountainous region, not even along the railway which reached the Pacific at Prince Rupert. Stewart on the borders of Alaska serves the Premier mines. (The road down the Skeena is now completed, 1948.)

The second division is usually called the Interior Plateau. To the writer this seems a misnomer since the region is definitely more like a basin than a plateau. A true plateau should surely be reached by way of rather steep scarps on most of its borders. In British Columbia we have merely an uplifted Tertiary Basin. It is true that its general level is about 3,500 feet, but deep valleys are incised in it in which much of the sparse settlement occurs, and nowhere

[1] 'Fiord-land of British Columbia', M. A. Peacock, *Geol. Soc.*, New York, 1935.

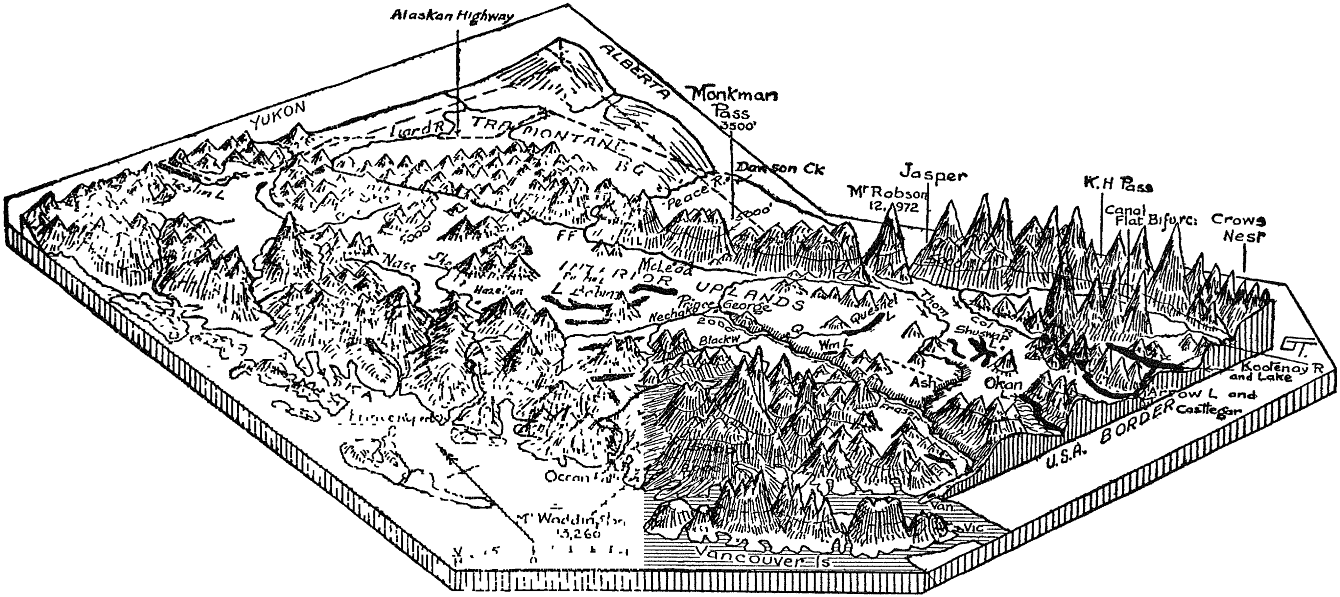


FIG. 62.—Block Diagram of British Columbia looking to the north-east. The positions of the 2,000- and 5,000-feet contours are indicated in places. Just north-west of L. Quesnel, Mt. Titan (or Laurier) rises to 11,000 feet in the high Caribou Mountains (*Geog. Soc. Philad*, Vol. XXV, p. 68). The main lakes are shown black, and the whole sketch is somewhat generalized

are there any widespread flat expanses. Hence the name Interior Uplands seems better suited to such an uplifted basin (or '*el-basin*'). In the block diagram (Fig. 62) I have omitted details of the topography between 5,000 and 3,000 feet in this division. The continuity of the Interior Uplands is thus emphasized. It is worth noting, however, that the floor of the deep narrow canyon of the middle Fraser River is below 2,000 feet, and this contour reaches north to the district around Prince George.

The third division is the Selkirk Ranges. These are built of intrusive rocks for the most part and were formed much earlier than were the Rockies. They receive a greater rainfall and are clothed in denser forests. Mining is quite important here also. For all these reasons it seemed worthwhile to separate them from the Rockies to the east. One of the most striking features is the prevalence of Topographic Trenches in this division. Bordering the Rockies on the west for nearly 900 miles is a well-marked 'groove'. It is not very deep in places, and its floor is by no means level. Naturally the main rivers flow along it, some sections having a northerly drainage, others in the opposite direction. In the main Rocky Mountain Trench flow the Kachika northward to the Liard, the Finlay south to the Peace, the Parsnip north to the Peace. In its more southern portion we find this Trench containing the Canoe River flowing south, and the main stream of the Fraser here flowing north. It seems probable that the proposed railway to Alaska will follow this remarkable Trench. At Canal Flat is the most interesting river divide that the writer has seen anywhere in the world. Here the Columbia River rises and flows north to the Big Bend while the main stream of the Kootenay flows south. Yet two tiny distributaries carry some of its waters to the Columbia. This unique bifurcation is described later (Fig. 70). In the United States the Rocky Mountain Trench continues as far south as Flathead Lake.

From near the Big Bend of the Columbia two other similar 'grooves' or trenches run southwards (Fig. 62). One is the Purcell Trench, much of which has been so gouged out by glaciers, &c., that it contains the large Kootenay Lake. The third 'groove' is the Selkirk Trench, which is also drowned in part in the two elongated Arrow Lakes. It seems probable that the long narrow trough occupied by Okanagan Lake has much in common with the other three described above.

In many places these trenches are bounded by mountains rising many thousands of feet above their floors, as near Canal Flat, or along much of Kootenay Lake. In other portions, as for instance near Yellowhead Pass and Fort Macleod, the Trench is not so well defined. It is usually stated that these trenches are due to faulting, and so in part resemble the gigantic feature in East Africa called the

Great Rift valley. But in some places no faults have so far been detected, and perhaps here they are slight downfolds. The canoe-shaped pattern of the Kootenay-Columbia system (Fig. 65) resembles that of certain dipping anticlines in the Appalachian Folds, and is perhaps worth noting.

The fourth division includes the mountains produced by the Laramide Revolution. There are many peaks rising over 10,000 feet, often of pyramidal shape where the ancient rocks involved are nearly horizontal. This is the case in the central portion of the folded crust around Kicking Horse Pass, and Mount Temple is one such pyramid showing 6,000 feet of almost level Cambrian deposits (see

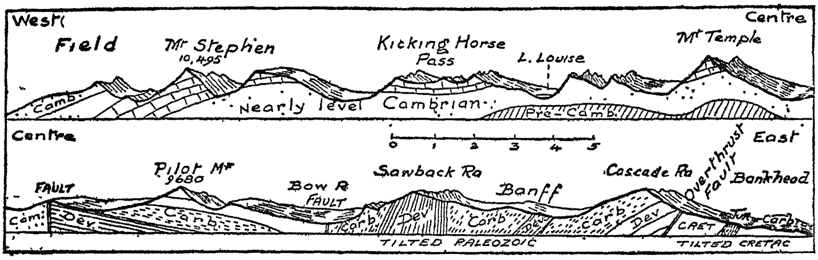


FIG. 63.—Geological profile section across the Rockies from Field to Banff. (Based on the *Transcontinental Geological Guide*, 1913)

Fig. 63). On the eastern side hereabouts the Paleozoic rocks are steeply tilted. To the south Cretaceous rocks containing coal are involved in the folding, as near Crow's Nest.

The passes are in general rather low, considering the height of the mountains. The best known at Kicking Horse is one of the highest at 5,338 feet. The broad flat valley of the Bow River, over-deepened by ice, offers a grand corridor on the eastern side. The difficulties of communication are found on the western side. The circular (really spiral) Tunnels enabling the descent to be made to the flat valley at Field are indicated in Fig. 64. The post-glacial notches cut by the rivers since the Ice Age have necessitated many bridges and much difficult railway engineering. Indeed, nowhere in the world are there more extensive scenic railway journeys than along the two Canadian Pacific routes across British Columbia to Vancouver (Fig. 64).

Crow's Nest Pass on the southern railway is only 4,459 feet above sea level. Yellowhead Pass far to the north carries the Canadian National Railway across at a height of 3,700 feet. There are several good roads across the Rockies; two are parallel to the southern railways, while a third crosses the Vermilion Pass just west of Banff at a height of 5,416 feet. Of special interest is the Monkman Pass,

which leads from the Peace River region in 'Tramontane', British Columbia, to the railway near Prince George (Fig. 65). It is at a height of 3,550 feet, and the road 172 miles long has been largely constructed by the unpaid labour of settlers who lived at the two ends of the mountain road. It was started in 1936 and is now nearing completion. Another road *via* Pine Pass (2,850 feet) is projected, and this is about 90 miles north-west of Monkman Pass.

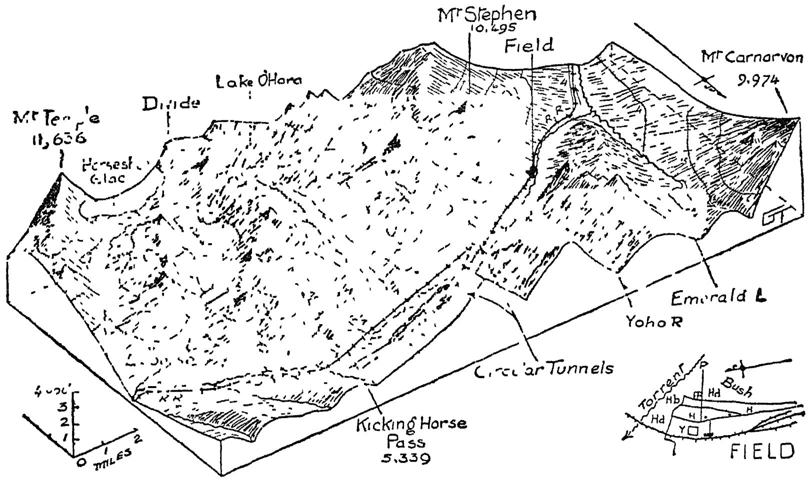


FIG. 64.—Block Diagram of Kicking Horse Pass, looking to the south-west. Notice especially the position of Lake Louise, the divide, and the circular tunnels. The 'division' town of Field is charted in the inset.

One further feature of the Rockies area must be briefly referred to. The crest of the mountains and the actual water parting between the Pacific and the Arctic Oceans here run along very different lines. The southern portions of these two lines are shown in Fig. 62. Peace River is clearly an antecedent river, following probably much the same course throughout Tertiary time. Hence the river has cut down its gorge at Finlay Forks (F.F. in Fig. 62) at about the same rate as the Rocky Mountains were elevated during the Laramide Revolution. The river at this famous gorge was first traversed by Mackenzie in 1793, and is only 1,900 feet above sea level. But the gorge is narrow and rather difficult to traverse; and it seems likely that the Pine Pass [1] or Monkman roads will greatly reduce its importance as a gate into western British Columbia.

The last division of British Columbia may be briefly referred to. It consists of an entirely different topography in the basin of the

[1] It is proposed to build a new road in 1945–6 from Prince George via Summit Lake through Pine Pass (2,850 feet) down Pine River to Commotion Creek. Here a road 85 miles long connects with Dawson Creek.

Peace River, which flows into the Mackenzie and so reaches the Arctic Ocean (Fig. 62). Here a huge area of rolling diversified country, much more level than in the other parts of the province, has been marked out as the 'Peace River Block'. All the farms so far settled are in this section, but since it only constitutes about one-tenth of the region west of the main Rockies, the term *Tramontane Division* seems appropriate for the whole region. Here the first settlement in the whole province occurred in 1798, when a trading post was opened at Rocky Mountain House. It is worth noting that the region around Vancouver had hardly an inhabitant before 1846.

NATURAL REGION 7 : VANCOUVER AND VICINITY

Included in this region is the south-west corner of the province of British Columbia ('1' in Fig. 65). It is highly mountainous

BRITISH COLUMBIA

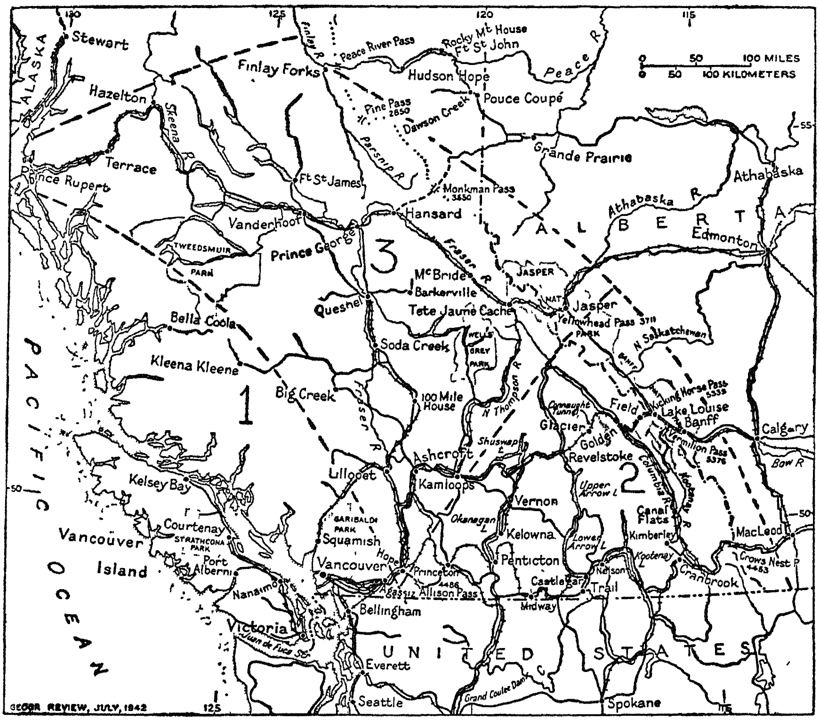


FIG. 65.—Map of the southern half of British Columbia to show the main roads and railways. All the roads on the fringe of settlement in 1941 are shown. 1, 2, 3, indicate the divisions of southern British Columbia. (From *Geographical Review*, 1942)

along the coast, and the large island named after Vancouver is also for the most part mountainous. There are, however, several rather large areas of more level land, and it is in one of these that the bulk of the people of British Columbia live. Thus there are two important sub-regions to be described in some detail. These are the Fraser Delta, with the large city of Vancouver as its nucleus; and the south-east shores of Vancouver Island, where many farms are flourishing to the north of the provincial capital at Victoria.

Much of the topography of the Fraser Delta has been discussed in an earlier section, where the soil characters are described (p. 89). The delta has filled a wide bay between the high ridges of the Coast Mountains (5,000 feet) in the north and the less imposing mountains to the east of Bellingham (U.S.A.). Each side of the triangular area of lowland thus formed is about 45 miles long.[1] Thus the total area, including much besides the latest delta deposits, is approximately 1,500 square miles. Of this area there are about half a million acres of arable land within the province. (A great deal of the low-level plain is within the territory of Washington State.)

The climate of this very diversified province varies very greatly for two main reasons. The topography shuts off the interior from the mild, warm, wet winds from the Pacific; so that the range of temperature soon increases as we leave the west coast, while the rainfall falls correspondingly. This is shown fairly well in Fig. 59, where the hythergraphs of Vancouver and Victoria are given. In both of these cities the range of temperature is quite small, since they are on the sea. But the city of Victoria is in the lee of the main mountains on Vancouver Island, so that its total rainfall is only 29·7 inches; while Vancouver, which fronts the ocean winds from the west, receives 58·7 inches. By the time we have moved eastward to Penticton on Lake Okanagan, the rainfall has fallen to 11·3 inches; and the hythergraph, so far from being of the Mediterranean pattern shown by the two coastal cities, is of the same pattern as Medicine Hat. Only the two extreme months are shown in Fig. 59 for Penticton, and these are joined by a heavy broken line (which is the main axis of the hythergraph), since there is no space to plot all twelve monthly positions. Most of the remaining places in British Columbia vary between graphs like Victoria on the coast, and those like Penticton in the interior.

The map given at the top left of Fig. 66 shows that only the fringe of the province has what may be called a 'marine' climate. This type is shown dotted. The Interior Uplands are of the 'moderate continental' type, while the Peace River Block across the Rockies is naturally very like the rest of the prairies with an 'extreme continental' climate. As regards temperatures, the mountain areas

[1] *Geology of the Fraser River*, Mem. 125, Geol. Survey, Ottawa, 1921.

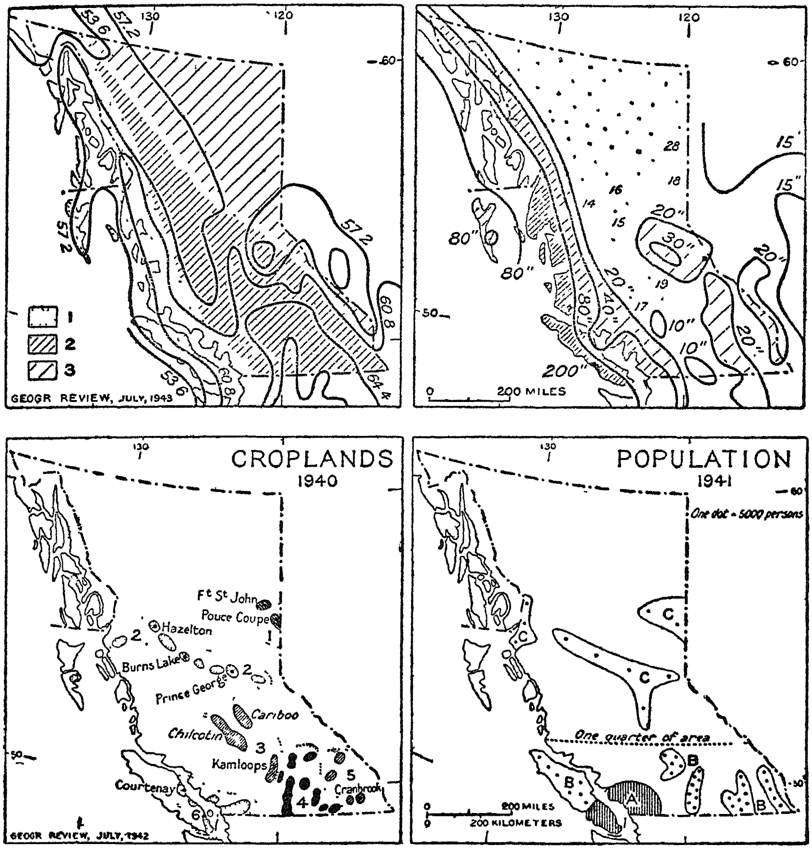


FIG. 66.—Four maps of British Columbia to show July temperatures and rainfall in two *upper* maps; and croplands and population in the two *lower* maps. Note that 93 per cent of the population is in the southern quarter of the province. (Croplands, 1 wheat, 2 pioneer, 3 and 5 ranches, 4 fruit, 6 truck.) The top right-hand map shows *annual* rain.

are of course quite cold even in summer. The highest mountain of all is quite close to the coast in the Coastal Range. It is Mt. Waddington (13,260 feet) which is a good deal higher than any peak in the Rockies in this province (Fig. 62). It is important to note the position of the isotherm for 57° F. in July. This is shown on the same map (Fig. 66); and it is generally assumed that lands with summers warmer than this are capable of growing grains and other valuable crops. Apart from a 'cool loop' projecting down the north-west side of the province, most of it has temperatures above 57° F. in July. The land is however rather rocky, and large areas of good soil are absent except along the valleys of the main rivers.

The notable falling off of the rain as distance increases from the Pacific is clearly indicated in the right-hand map (Fig. 66). Although it is true that one station on Vancouver Island (Henderson Lake) receives 200 inches a year (probably the highest in North America), yet Clinton on the Fraser River only a relatively short distance to the east has an annual rainfall of less than 7 inches. Penticton, along a similar north–south valley, is also in a rain-shadow, and its rainfall is only 12 inches. Since the topography determines the distribution of the croplands, and also the temperature and rainfall, there is no better region in the world for exhibiting the importance of topographic control.

The settled areas in our present 'Vancouver Region' will be found to agree pretty closely with Halliday's 'Southern Coast' and 'Madrona-Oak' forest sections. The latter area comprises merely the shores of Puget Sound; and is characterized by the presence of two trees which are found nowhere else in Canada, though they are abundant in the State of Washington. These trees are the madrona, and the garry oak. They manage to survive in this corner of Canada because it is the sole area in the Dominion whose average temperature does not fall to freezing-point in any month of the year. Of course, the common trees of the Pacific coast occur also in this nteresting sub-region (Fig. 113).

The 'Southern Coast' Forest covers the delta and most of Vancouver Island. Here Western red cedar and Western hemlock (Fig. 113) are the commoner trees, though Douglas fir and Western white pine are also abundant. Black cottonwood, red alder, and broad-leafed maple are also characteristic of the fine forests in this corner of Canada. A large timber industry has developed, which is described in a later section (p. 359).

Settlements on the Fraser Delta

The delta is being built out to sea at the rate of about 10 feet a year. Burrard Inlet is a fine harbour having today no connexion with the Fraser River. The basal Eocene rocks outcrop near Vancouver, but in general the delta deposits are very deep. For instance, near Steveston a bore penetrated 1,000 feet of soft deposits before it reached the hard shales of the basal rock. However, the surface of the delta has been largely covered by glacial till. This rises to about 350 feet in the north, where the till has been largely covered with the streets and houses of modern Vancouver. To the south are small valleys in the delta deposits and till, crossed by streams like the Serpentine.

During Pleistocene times the area was twice over-ridden by ice; and, later, extensive glacial outwash deposits were formed. Since the last retreat the latest deposits consist of river alluvial in which

many peat bogs have developed. In post-glacial times the area was uplifted several hundred feet, but the relative position of sea and land has been stable for the last few thousand years. This is indicated by the wide wave-cut platforms extending seawards for a thousand feet near Kitsilano.

On this low-lying area are to be found many of the chief settlements in the province. There is one large city, Vancouver (344,833); one large town, New Westminster (28,639), and four small inland towns, Chilliwack (5,663), Mission (2,668), Port Coquitlan (3,232), and Port Moody (2,246); with two others, Lardner and Steveston, on the coast. There are also about fifty villages which extend along the three parallel routes, i.e. the two railway lines and the main road to the interior.

The City of Vancouver

In 1792 the Spaniard Valdez and the Britisher Vancouver made surveys of the coast near Vancouver. The first settlement in the province, however, was in 1798 far away at Rocky Mountain House on the Peace River. From this region Fraser started his long journey down the centre of the province and camped at the mouth of the Fraser in 1808. The fur post of Kamloops was built in 1812, while Fort Langley on the delta dates from 1827. The first large settlement was at Fort Victoria (1842) on Vancouver Island, and it was not till 1860 that some farmers settled near Stave River on the mainland. The discovery of gold in the Fraser River near Hope about 1854 soon led to the arrival of 10,000 miners in the lower Fraser valley.

In 1857 New Westminster was founded as an administrative centre for the mainland. In the same year some lignite was found at the site of Vancouver, and gave rise to the early name Coal Harbour (Fig. 67). In 1862 the first house was built by John Morton near the site of Marine Building. In 1884 Van Horne of the C.P.R. realized the advantages of Coal Harbour as a terminal port, and suggested the name of Vancouver for the new settlement at the end of the transcontinental railway. In May 1887 the first through passenger train reached Vancouver. In June 1886 a disastrous fire destroyed practically every building in the little town. However, the town was soon rebuilt, and the nucleus was naturally the C.P.R. station on Coal Harbour (Fig. 67). My survey was made in 1941.

There are ridges of silt and till between Burrard Inlet and the Fraser River, and the chief streets of the city now occupy the small northern ridge which rises about 120 feet above the sea. At the end of this ridge has been created Stanley Park, which is one of the most attractive parks in the world. By 1898 (as the inset in Fig. 67 shows) the main stores and offices were covering both sides of Granville Street and had nearly reached False Creek to the south.

Numerous residences occupied the rest of the peninsula, and a few clusters had developed to the south of False Creek. The interests of the little town centred largely in lumber; and timber merchants and mill-owners soon occupied the shores of this little harbour, as indeed they do to this day (see photo, p. 192).

The population reached 50,000 about 1906, and 100,000 about 1912. After a decline due to the war, the figures climbed rapidly to 200,000 in 1928. Since this time the growth has been much less rapid, and in 1956 it was 366,000.

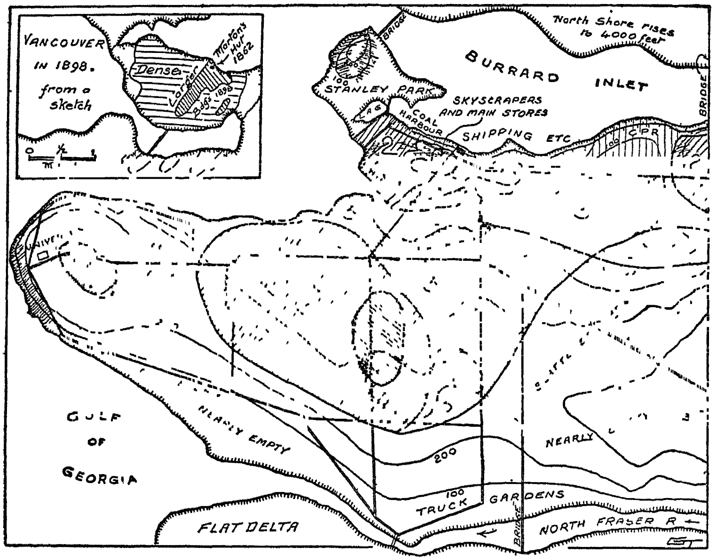


FIG. 67.—A simplified functional plan of Vancouver. The silt ridge between Burrard Inlet and False Creek (120 feet high) is the core of the city. Inset is a map (to the same scale) of the town in 1898. Best houses at (1)

Today the functional zones of the city have a definite pattern which naturally depends in part on the environment. The half a dozen skyscrapers are all within a mile of the nucleus. Large shops and department stores have displaced the earlier business buildings on the slopes leading to the summit of the peninsula. Smaller shops fill a circle of about one mile diameter around the first zone. Between the shops and Stanley Park is a district of large houses which formerly represented the best residential section. Now many are used as flats, and a number of apartment houses have been erected, so that today this area is mostly second class (2). Above False Creek is an enclave of third-class houses (3) jammed against the factories surrounding False Creek. The main steamer wharves of the city are along Burrard Inlet, and adjacent are the large warehouses. The

swampy land at the head of False Creek formed an unattractive site, where the Chinese and Japanese quarters have developed.

New Westminster is the next largest town to Vancouver on the delta. It is situated on the Fraser River about 12 miles above where it becomes salty. The little town is largely engaged in lumbering and in derivative industries, such as furniture-making, pulp- and paper-mills. Ladner is 12 miles south of Vancouver, and is linked by steamers to the two adjacent cities. Mission, about 42 miles east of Vancouver, is a dairying and fruit-growing district. Port Coquitlan and Port Moody are small towns east of Vancouver on the edge of the mountain zone to the north. Steveston is on Lulu Island, one of the delta islands, and was largely inhabited by Japanese before the war. Fishing and salmon-canning engaged their attention. Chilliwack and Agassiz are higher up the Fraser where the delta is just beginning to form. Dairying, stock raising, and lumbering are important here. Agassiz has extensive hop gardens.

The coast north of Vancouver is so rugged, and so deeply indented by fiords, that widespread settlement is impossible. Howe Sound is the first large gulf to the north, and here is the famous Britannia Mine, where very large copper deposits have been worked. At the head of the Sound is Squamish, where a railway to Lilloet and Quesnel leads to the heart of the Interior Uplands. Apart from some important lumber- and pulp-mills, such as the one at Ocean Falls, there is very little settlement along the coast as far as Prince Rupert. There are a few Indian villages and some farms near Bella Coola, but so far all traffic is by boat, and no road has yet crossed the coastal mountains from the interior. At the north end of Bute Inlet about 40 miles from tidewater is Mt. Waddington, which is 13,260 feet high (Fig. 62). Its slopes bear a number of glaciers, some being ten miles in length.

Vancouver Island and Victoria

As mentioned earlier, this large island was folded and uplifted during the early Tertiary mountain-building period. Many of the rocks are of Cretaceous age, including the valuable coal-bearing series at Nanaimo on the east coast. But the geology is rather complex, and several other uplifts since the one in early Tertiary times have occurred. At the south end of the island the mountains are rather flat-topped, and are separated from each other by broad valleys which have been in part carved by by-gone glaciers. There are a number of long deep fiords on the west coast, of which the Alberni Canal and Nootka Sound are the best known (Fig. 68). The highest point is Victoria Peak (7,484 feet) near the centre of the island, but many of the summits of the southern mountains are less than half this height. The heavy rainfall has resulted in much of

the island being covered with dense forests. Here is to be found some of the best lumber now remaining in the province.

The rainfall in much of the large island is too heavy to be satisfactory for many crops. Luckily this is not the case on the east coast, where Victoria receives less than 30 inches a year, and has a very pleasant climate. North of the capital is the largest extent of fairly level agricultural land, and accordingly here farms spread up the coast almost as far as the narrow Discovery Passage (Fig. 68). The Saanich Peninsula just north of Victoria is an important centre for dairying and truck gardens. Around Duncan poultry and potatoes are also grown to a considerable extent. Two small farming towns are Courtenay (2,553) and Nanaimo (7,196), with much the same interests, though the coal-field near and to the north-west of Nanaimo is also worked to a considerable degree. This coast is

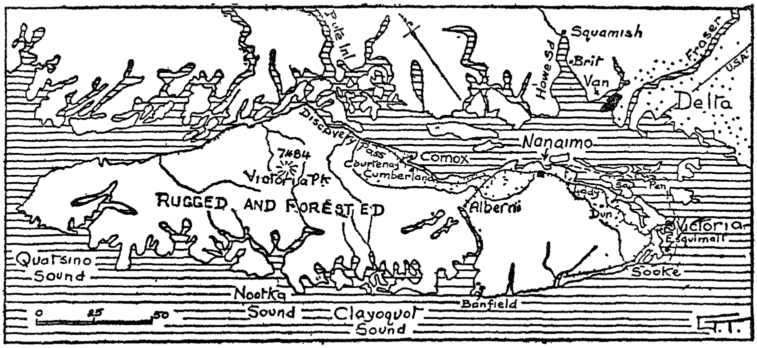


FIG. 68.—Vancouver Island and the adjacent coast, looking to the north-east. Lowlands dotted. Zeballos is 40 miles west of Victoria Peak

served by railways which reach as far as the Courtenay district, and branches serve Port Alberni (7,845) where a low-level valley links the east coast to the deep fiord of the Alberni ' Canal '. Its timber trade is discussed later. Several of the small islands to the north of Victoria, such as Saltspring and Pender (Fig. 68), are found to be satisfactory for crops of the same sort as those grown nearby on the mainland.

Victoria was founded in 1843 by Governor Douglas as a fort to replace the settlements on the Columbia River, which were ceded to the United States about this time. In 1849 the island was proclaimed a British colony and was controlled by the Hudson's Bay Company. But it grew very slowly, as it was about the most difficult to reach of all the British possessions. In 1858 the mainland was proclaimed a separate colony called ' New Caledonia ', but this name was soon changed to ' British Columbia '. For a time New Westminster was its capital, but in 1866 both areas were united under the

present name, and the combined capital was declared to be Victoria.

The capital of the province is sixteenth among the cities of the Dominion, and is therefore far smaller than Vancouver, which ranks third. Its population is about 55,000 (Fig. 158).

There are handsome parliament and other buildings in Victoria, and it is a great tourist centre for Americans as well as Canadians. It is noted for its mild winters, and for the abundance of flowers through the year. Nearby is the important naval port of Esquimalt (5,000), with one of the largest dry docks in the world. Pleasant highways lead northward to the east coast, passing (near Victoria) a sample of a reversing fall, and the important Dominion Observatory. The island is noted for fishing and hunting, especially the salmon at Campbell River (north of Comox), and the trout in Lake Cowichan (west of Duncan).

NATURAL REGION 8: THE SELKIRK REGION [1]

This region is rather hard to define, but may be taken to comprise all the mountainous country to the east and south-east of the Thompson and lower Fraser Rivers (' 2 ' in Fig. 65). As mentioned earlier it consists of five more or less parallel ranges separated by deep elongated valleys, usually containing lakes. For convenience the area of the Rockies, including and south of Mt. Robson (Fig. 65), may be incorporated; and the region therefore overlaps the British Columbia boundary and includes the famous tourist districts around Jasper, Banff, and Lake Louise, which are in Alberta.

The topographic features of this region have already been discussed in a general fashion. The characteristic long narrow lakes point to a relatively young topography, which still retains features due to crustal folding and to late glacial erosion. The problems are some of the most complex in the world, and nowhere has the writer studied glacial deposition and erosion under more puzzling conditions. Not only have we several periods of ice erosion, but also remarkable elevations and subsidences amounting to several thousand feet going on during much the same time.

Between the Fraser Canyon near Yale and the Alberta Prairies near Macleod, there is a succession of valleys and ranges which are hardly rivalled in any part of the Empire with a British population. This series of north–south valleys, as stated, is connected with the main mountain-building forces, which acted mostly from the west. In order there are nine or ten of these sub-parallel trenches separated from each other by ranges rising to 10,000 feet in the Selkirks and Rockies, but to less elevations in the other divides.

In a journey from Hope (near Yale) to Crow's Nest Pass far to the east, the railway climbs successively the following heights: Hope (144 feet) to Coquihalla (3,658); Princeton (1,120) to Osprey

[1] Selkirk Region is of course not a *geological* unit.

(3,592); Penticton (1,120) to Myra (4,160); Midway (1,903) to Eholt (3,087); Grand Forks (1,733) to Farron (3,976); Kootenay (1,773) to Fassifern (3,260); Wardner (2,490) to Crow's Nest (4,450). Few railways can have been so expensive to build, and the chief freight today consists of ore from the Kimberley mine and coal from Fernie, which are carried to the great smelters at Trail. Fruit, timber, and tourists all add considerably to the earnings of this railway. Its lakes and mountains are as attractive scenically as are the canyons and river-views on the main Canadian Pacific line, which runs along the Fraser valley. Each of the long narrow valleys has much the same appearance, though in some cases a lake adds to the beauty of the scene, but reduces the arable land.

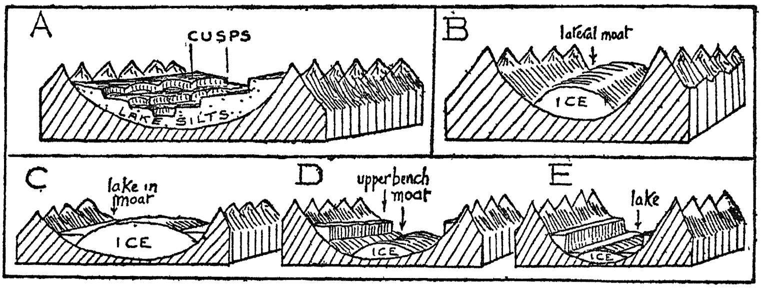


FIG. 69.—Sketch sections illustrating various theories as to the origin of the terraces or benches. At A a river has cut terraces in thick lake-silts. At B is the condition of many Antarctic glaciers. At C linear lakes fill the lateral moats. At D the ice is at a lower level. At E lakes and silt are formed again. C, D, E, seem to explain the terraces in British Columbia

Okanagan and Kootenay Lakes are each about 70 miles long; while the two Arrow Lakes are separated by an infilled portion of their valley about 20 miles long. Each of the two lake-filled portions of the deep valley is about 40 miles long. Kettle Valley and the Kootenay valley contain no lakes; and since the eastern valley is very dry, it is largely devoted to ranching. But in every case there is a river if not a lake in the valley, so that irrigation helps to offset the absence of lake waters. The Nicola valley and Elk River valley (near Fernie) are not so wide or well-developed as the others mentioned.

The Origin of the River Terraces

The outstanding features of all these valleys are the numerous terraces which run for miles along the slopes on each side of the river. In some cases, as at Summerland on Lake Okanagan, there are a half-dozen of these terraces, one above the other. They are very

like railway embankments, moulded along the sides of the valleys; and the outstanding feature is that their scarps are invariably straight. They exhibit none of the cusps and curves (Fig. 69 at A) which are always present where lake-silts are cut into by a river which is carrying such silts downstream, after it has breached the dam which held back the former lake. Since a large part of the settlement of the interior of British Columbia has taken place on these terraces, it will not be out of place to devote a few moments to a theory as to their origin (see Fig. 74 and p. 195).

When in the Antarctic in 1910–11–12, the writer was much struck by the 'lateral moats' which bounded all the larger glaciers. In no case did the great masses of ice directly contact the high slopes and cliffs, which bounded the glacial troughs; but an empty 'valley' lay between the glacier ice and the steep mountain-side. Alongside the Ferrar Glacier this moat was 200 feet deep, and about 100 feet wide at the bottom. It was four or five times this width at the level of the surface of the glacier (Fig. 69 at B.). In places where conditions were favourable—as for instance alongside the New Glacier in Granite Harbour—we found that debris from the slopes alongside had nearly filled this 'moat'. This debris would ultimately form a terrace along the side of the valley, when all the ice had been removed by the onset of a warmer period. I suggest that something of this sort occurred in British Columbia, adding that the remarkable elevations and subsidences may have brought about changes of climate at any given spot, which can hardly have been experienced in many other regions containing large glaciers.

If we assume that the period since the last major ice age was marked by alternating cold dry phases and wetter (somewhat warmer) phases, but in general by a *waning* ice condition, then I think we can reconstruct what happened. All the terraces are Post-Wurm, since no feature can be less permanent than a mass of debris piled on a steep slope in a region subject to rains. The temperature would be around or below 32° F. in the short summers, so that very little thawing of the massive glacier ice would occur while the silt was deposited.

In the first section (A) in Fig. 69 we see a sketch suggesting the conventional explanation of the benches as *lake-silts*. There are, however, no cusps (due to river erosion) visible in the B.C. benches. In the next section (B) I show the cross-section of an Antarctic glacier and its lateral moats. At C a lake fills each moat, and receives debris. In the fourth section (D) the glacier has waned greatly, but another cold dry phase produces lateral moats again at a lower level. Then a wet phase gives rise to lakes and silts as before. Seven terraces, such as are apparent at Summerland, indicate seven phases in the climate since the last major ice age (see also p. 202).

The Bifurcation of the Kootenay River at Canal Flat

It would be remarkable if this series of north–south valleys in the vicinity of the Selkirk Ranges had not produced some peculiarities in the drainage pattern of the modern rivers. I have only space to describe one of the most remarkable 'bifurcations' in the world, which is to be seen at Canal Flat at the source of the Columbia River. It depends on the presence of the 'Rocky Mountain Trench', itself one of the best-marked fold-valleys in the world (Fig. 62). Daly has pointed out that this trench is not cut down to a common level, but follows the ups and downs of the province hereabouts, somewhat as a military trench would do. The 'trench' starts in Idaho (U.S.A.) and extends north to the Liard River. It seems likely that it is continued—though not so regularly—by the upper Liard, Pelly, and

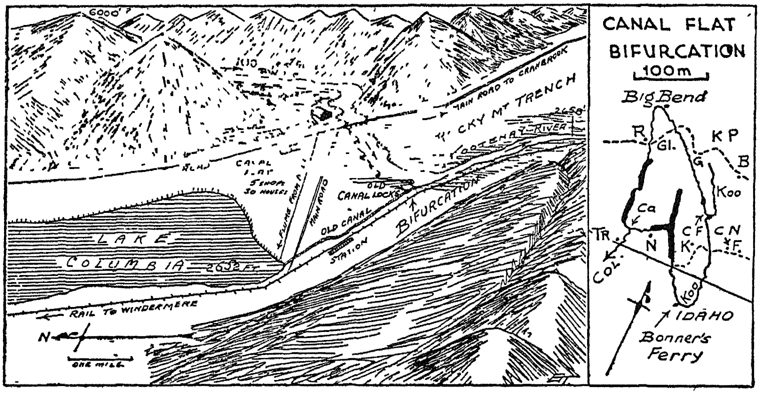


FIG. 70.—Sketch of the Kootenay-Columbia bifurcation in the Rocky Mountain Trench at Canal Flat; looking east. The small map at the right shows the Selkirk Ranges completely surrounded by the two rivers, which join at Canal Flat (C.F.) and again at Castlegar (Ca.)

middle Yukon Rivers as far as Alaska. This is a total distance of 1,800 miles, and the tectonic depression is clearly shown as a unit in the *southern* half of this topographic feature.

Vermilion River, a tributary of the Kootenay River, rises on the main divide immediately south of Field, and the Kootenay flows for nearly 400 miles before it joins the Columbia River at Castlegar (Fig. 70). At Canal Flat the Kootenay is 100 miles from its source, and here it is a large river flowing in a valley about 4,000 feet deep. At this place it reaches the 'Rocky Mountain Trench', whose flat floor is here about 3 miles wide. The Trench is bounded by ranges whose peaks are about 5,000 feet above the floor. One might expect topographic anomalies to develop in connexion with this remarkable depression, and indeed such is the case.

The writer has studied topography in seven continents but has not come across a parallel example. Of course, every case of incipient piracy is in a sense a tiny bifurcation, and they are not at all uncommon; but the Kootenay at Canal Flat is a strongly flowing river a hundred yards wide at the bridge on the main road (see the sketch given in Fig. 70). It then flows to the west across the gravels of the Trench between banks about 10 feet high. Here it makes contact with the headwaters of the Columbia, which actually rises at this point in the ruined locks of the long-abandoned canal. Some fifty years ago this canal functioned long enough to allow one barge to carry freight from the Kootenay into the Columbia system at Lake Columbia. At the lock the barge was lowered 10 feet from the Kootenay to the level of Lake Columbia. The opening of the 'Kettle Valley' Railway ruined its hope of traffic, and it never came into active operation.

There is, however, a second bifurcation in operation continuously to this day. A flume (FL. in Fig. 70) carries logs to a pool at the lumber-mill at Canal Flat. This pool is so much lower than the adjacent Kootenay River that its surplus water cannot be turned into the Kootenay, but is carried by an artificial channel cut in the gravels of the Trench to Lake Columbia about 2 miles away. This flume is used for a little casual irrigation of their crops by the residents of Canal Flat, and is a permanent stream. Furthermore, in heavy floods such as those of 1930 the Kootenay overflows its banks, and pours north over its banks into Lake Columbia. The latter empties normally into the Columbia, of which it forms the headwaters. It is difficult to understand why the Kootenay has not taken this slightly easier course to the sea some time earlier in its development.

Now let us examine what happens to these various branches of the Kootenay. A glance at the inset map in Fig. 70 shows us that the Columbia reaches the Big Bend in about 100 miles, and there turns south to reach Castlegar about 250 miles from its source at Canal Flat. It would seem logical to consider that the Kootenay is the *main* stream, since it is about 150 miles longer and is already a large river at Canal Flat, where the Columbia rises. The unique feature of the bifurcation is that it resembles a bypass on an arterial road. After the waters of the Columbia have flowed around the northern half of the Selkirks, and those of the Kootenay around the southern half, they come together a second time at Castlegar. This latter place is 1,380 feet above sea level, and therefore 1,280 feet below the source of the Columbia at Canal Flat. I know of no other bifurcation around a high mountain area where the tributaries come together again (inset map, Fig. 70).

One final glimpse at the unrivalled scenery offered to the traveller in the Rockies may be taken in the vicinity of the Kicking Horse Pass.

The whole district is clearly depicted in the block diagram given in Fig. 64. Here we are looking to the south-west over the pass and into the broad valley leading into British Columbia. The Continental Divide here includes peaks about 10,000 feet high, though the two highest in the sketch, Mt. Temple (11,636) and Mt. Stephen (10,495), lie each side of the Divide. The best-known glacier in the Canadian Rockies is the Victoria Glacier at Lake Louise, and this is shown at the left, with a portion of the larger Horseshoe Glacier to the east (Fig. 149).

The wide flat character of the Kicking Horse Pass is obvious. Immediately to the west, the Kicking Horse River drops rather rapidly, and here two circular (or spiral) tunnels have been cut in the sides of the valley to permit of a rather rapid descent of the railway to Field. Here is the 'division station', with a large cluster of repair shops, etc. Emerald Lake amid large conifers is a beautiful little lake reached from Field. Many fine waterfalls, not shown in the sketch, adorn the steep glacier-cut walls of this favourite tourist region (Fig. 64).

Further to the south is the Crow's Nest Pass which is situated in the midst of Cretaceous formations carrying valuable coal seams. Fernie and Blairmore are the two chief coal centres, one on each side of the pass. Near Blairmore on the Alberta side is Crow's Nest Mountain, which is a famous example of a 'mountain without roots'. This is due to the ancient Devonian rocks of the main range being thrust over the much younger Cretaceous rocks. Later erosion has removed the rocks connecting the summit with similar formations to the west, and there results a structure (*klippen*) which much puzzled early geologists. A few miles east of the mountain is Frank, where one of the largest landslides of modern times occurred. Here is Turtle Mountain hanging above the original little village of Frank. On 29th April, 1903, the face of the mountain slipped down, and covered an area of over a square mile with debris. Almost every house was destroyed, and it is said that 70 people lost their lives. The new village has been built a mile away, and far from any further falls of this description. (The positions of Frank, Crow's Nest, Kimberley, Nelson, Banff, Golden, and Revelstoke are shown by the initials in the small map in Fig. 70.)

A Traverse through the Valleys near the Selkirks

In 1941 I made a survey of many of the settlements in British Columbia, and published a lengthy account of them in the *Geographical Review* (New York) for July 1942. Many of the maps in this part of the book are taken from that article. The approximate boundaries dealt with in this region of the Selkirks are shown in Fig. 65, and so we may assume that the traverse began at Revelstoke,

where the Canadian Pacific Railway crosses the Columbia River, just to the west of the main ranges of the Selkirk Mountains proper. The town of Revelstoke (pop. 2,106) is situated on the bank of the river, but is somewhat unusual in that it is difficult to get a clear view of the beautiful river from any part of the town. Probably flooding accounts for the streets being set so far back from the river. A most interesting section of the traverse surrounds the little railway station at Glacier. Here the railway line climbs the Selkirks, reaching a height of 4,100 feet, before it enters the lengthy Connaught Tunnel near Roger's Pass. Formerly there was a C.P.R. hotel here, but it has been pulled down; and the most accessible glacier region in British Columbia is without accommodation for travellers. Only one small store and a few railway buildings are to be seen near the station.

I tramped to the Illecillewaet Glacier through a beautiful forest of cedars along paths bordered with mosses and flowers. Alongside were the cascades of the Asulkan Brook which rises far away in the Asulkan Glacier to the south. After 2 or 3 miles of forest the trail reaches the bare rocks below the glacier. On the way one crosses swampy heaths, patches of dwarf pine, and many large snowdrifts. The snow-field of the Illecillewaet Glacier covers 25 square miles, but the ice has been receding of late years. The snout of the glacier is about 5,000 feet, while its *névé* reaches to 9,000 feet. The peaks of the Selkirks, south of the large *névé*, reach to 11,000 feet.

From the Selkirk divide the railway drops down to the junction of the Purcell Trench with the Rocky Mountain Trench near Beavermouth. The former (Fig. 70) is 200 miles long, and extends south to Bonner's Ferry in Idaho. Near the U.S.A. boundary this interesting trench is due to a pronounced longitudinal fault, but at the north end its valley is eroded in an anticline, and no faults have been charted. The trench has been overdeepened by glaciers. Beavermouth on the Columbia is 2,485 feet above the sea, and the railway now follows this river along the Rocky Mountain Trench for 28 miles to Golden. This latter trench is 'located on a master longitudinal fault with a throw at least equivalent to the entire thickness of the Cambrian group' (19,000 feet).[1] Probably the erosion of the trench occupied much of Tertiary time, during which the softer rocks east of the fault were removed by rivers and later by ice.

Golden is a little lumber town which spreads out on both sides of the Kicking Horse River where it joins the Columbia River (Fig. 70). About 400 lived there at the time of my first visit in 1936, when it contained three churches and about a dozen shops.

[1] 'Guidebook of the Transcontinental Excursion', *Geol. Surv.*, Ottawa, 1913. Some geologists do not accept this opinion.

A fire in 1926 destroyed much of the forest, and the timber industry has never recovered from that setback. A disused lumber-mill which used to employ 200 men bears witness to its former importance. No road bridge crosses the Columbia here, but a precarious causeway of floating logs, spiked together into a line, is much used by outlying settlers.

From Golden the train climbs up the Kicking Horse valley to the continental divide at the pass of the same name. The river traverses tilted Silurian beds in which it has cut a canyon near Palliser; but near the Wapta Falls it crosses the wide Beaverfoot valley. Again where the river cuts across the softer Upper Cambrian rocks near Emerald it has eroded another broad valley nearly 2 miles wide. Just below Field it passes through a small natural tunnel in the vertical shales. The region to the south of Field containing the bifurcation of the Kootenay River has already been described. If we journey a few miles south of Canal Flat along the Trench, we reach one of the chief mines of Canada at Kimberley, and this will now be described.

Kimberley and the Sullivan Mine

From Canal Flat one may journey south along the Rocky Mountain Trench for 45 miles to Kimberley (pop. 1,500). On the west are the Purcell Ranges which are composed of Pre-Cambrian rocks and which originated much earlier than the Rockies. The great Trench is several miles wide and is characterized by an enormous extent of gravel plains and silt terraces. There is very little farming, since this is rather an arid area. The sparse cover of pine was cut for lumber long ago, and ranching is now the chief occupation except for small irrigated areas where the conditions are most suitable. However, it is in this empty region that the Sullivan Mine, one of the largest lead-zinc mines in the world, is to be found.

The Sullivan lode was worked as far back as 1892, but not much development was done until it came into the hands of the present company which obtained control in 1909. This company also runs the huge smelters and chemical works at Trail (Fig. 71). In 1899 the branch railway line to Kimberley was constructed, and since 1914 the Sullivan Mine has been the largest producer of lead and zinc in Canada.

The ore body is about 200 feet thick and seems to have replaced Cambrian quartzites. It dips to the east at an angle of about 23 degrees. The ore consists chiefly of a fine-grained mixture of galena and blende. Probably the mineral is ultimately derived from igneous intrusions, but none seems to be apparent near this huge deposit.[1]

[1] E. S. Moore, *Mineral Resources of Canada*, Toronto, 1927.

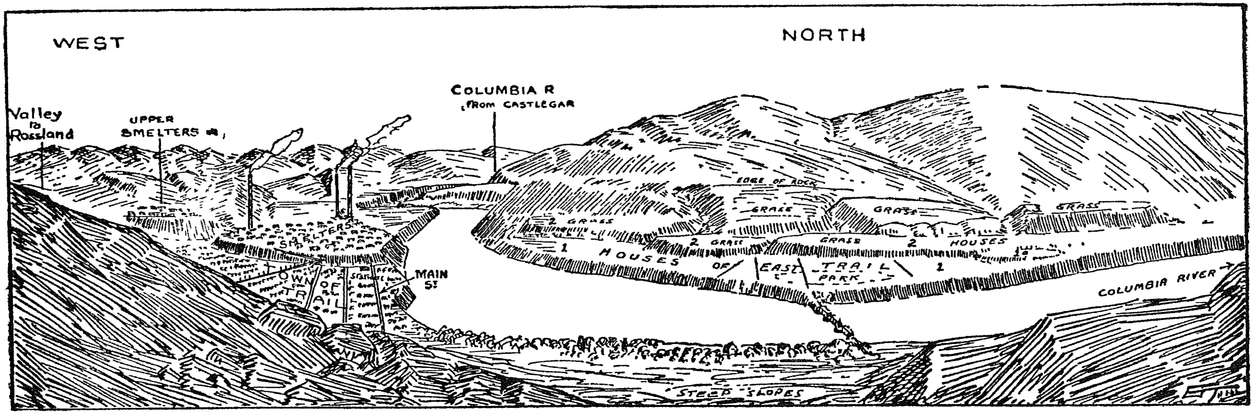


FIG. 71.—Sketch of Trail, showing the huge smelting works, the town on several terraces, and the Columbia River

The ore is worked by a tunnel which runs for more than a mile into the side of Sullivan Hill (Fig. 140) from the bottom of Mark Creek valley. Large crushers are erected at the mouth of this tunnel, but much of the ore is taken to concentrators about 3 miles down the valley (Fig. 140). Some of the sulphide is converted into sulphuric acid at Trail and used in the preparation of fertilizers.

Castlegar, Trail, and the Kootenay Region

The south-east corner of British Columbia is known as the Kootenay area. The section dealing with communications will have prepared the reader for the main features of the topography. The route I followed led over all the mountain divides there described, and I will now add a few words on the settlement. Cranbrook, just south of Kimberley, is a town of about 3,600 people, but it has lost nearly 500 in the last ten years. It is still an important lumber centre, and the colossal heaps of sawdust (now used for central heating in places) are an unusual feature. The railway to the west passes close to the border at Yahk, which is a mountain centre in timbered country, but there is very little settlement along this part of the country.

Near Erickson is a small canyon cut in the floor of a flat valley several miles wide. Orchards become numerous as we reach Creston where we again strike the Kootenay River, now flowing north into Lake Kootenay (Fig. 65). Hereabouts the river meanders over the flats nearly 3 miles wide, which represent delta deposits recently laid down in the lake. Two pairs of levees, 4 miles long, protrude into the lake along the main distributaries of the Kootenay River. Formerly it was necessary to take the steamer to Proctor, but about twelve years ago this last gap in the railway was closed. There is very little traffic on the lake now, and a few orchards on the largest fans around the lake support the meagre population. The lake is 65 miles long and its greatest depth is about 450 feet.

At Proctor the west arm of the lake leads to Nelson which is about 20 miles west of the main lake. This town of 6,772 people developed as the result of many mines opened in the Jurassic granite and adjacent formations. It is now chiefly interested in lumber and fruit. In the 22 miles east of Castlegar the river drops 335 feet, and several hydro-electric plants take advantage of this source of power. It is stated that 200,000 horse-power can be developed from these falls near Bonnington. To the west the river follows for 10 miles a rather narrow valley cut in the granite rocks, until it reaches the junction of the Kootenay and the Columbia at Castlegar.

The interesting position of Castlegar has already been discussed. Here the Kootenay, after its course of about 100 miles in the United States, joins the Columbia at a level of 1,380 feet above the sea.

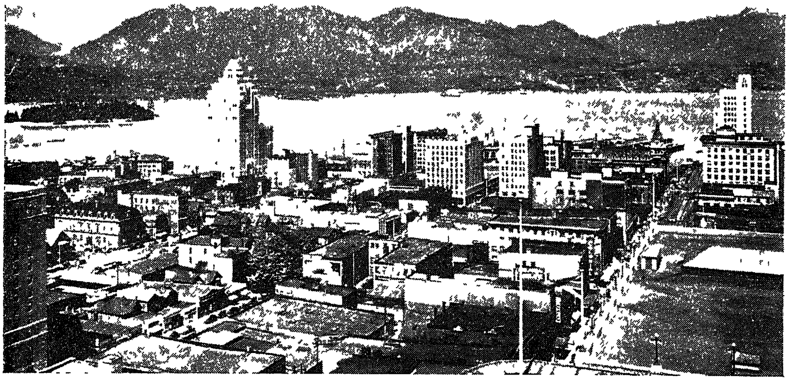


PHOTO 7.—VIEW OF VANCOUVER HARBOUR, LOOKING TO THE NORTH (p. 10)

PHOTO 8.—THE ' POLAR SEA ' DAIRY, NORTH OF THE ARCTIC CIRCLE AT AKLAVIK (p. 10)

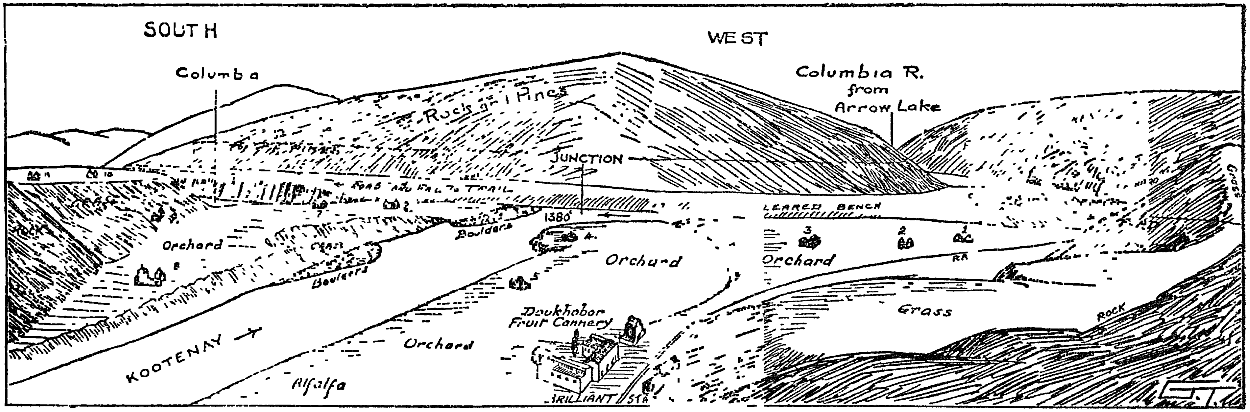


FIG. 72.—Sketch of the junction of the Kootenay with the Columbia at Castlegar. The view is down the Kootenay, and the combined river flows to the left. The Doukhobor centre of Brilliant is in the foreground, and eleven of its communal houses are sketched (*Geog. Rev.*, 1942)

The courses of the two rivers are clearly shown in Fig. 70. Several very prominent terraces are to be seen at Castlegar. The Doukhobors early realized the value of these terraces for fruit culture, and in 1908 about 4,000 members of this interesting religious sect migrated from Saskatchewan to the lower Kootenay (Fig. 72).

Each communal house of the Doukhobors is built to the same plan, and consists of two peaked buildings joined by a one-storey 'wing'; and from 50 to 100 people live in each of these communal houses. They are an industrious and peaceable folk, but they object to military service and to ordinary school education, so that they constitute rather a sociological problem in Canada. Their large canning factory was built on borrowed money, which they are now unable to repay. Hence the factory was closed during my visit in 1941. They irrigate the terraces by wooden pipes, which come from a reservoir on Pass Creek four miles to the north of Brilliant. The tomb of their leader Peter Verigin has a striking position just where the Kootenay leaves its rocky canyon.

Castlegar on the Columbia River, a mile above the junction of rivers, is chiefly noted as the place where the branch-line leaves the 'Kettle Valley' Railway to reach the smelters at Trail. A number of Doukhobors live here among the other settlers, but they have occupied ordinary small wooden houses. There are about sixty houses in the settlement, a new hotel, and about four shops. An iron bridge carries the C.P.R. over the river, but automobiles must still cross by the Government ferry, which is free and runs day and night. Novel features in the river near the bridge are the rafts carrying pumps, which are worked by waterwheels hanging in the swift river. The pumps lift the water about 40 feet to small irrigated gardens in the south-east part of Castlegar. Just across the river a large lumber-mill employs a number of residents in Castlegar.

The settlement at Trail started about 1895, when the first smelter was built to treat ore from the adjacent mines (Fig. 71). The railway from Nelson reached Trail in 1898, and the smelters were taken over by the Consolidated Company in 1906. Many of the Rossland mines nearby became exhausted about 1920, and today Rossland is mainly a residential 'suburb' of Trail.[1] About 1927 the large fertilizer plant began to operate, and used a good deal of the sulphur by-products from the smelters. Today Trail has a population of 11,430, while Rossland contains 4,604. Both towns have grown considerably in the last ten years.

The sketch in Fig. 71 shows the way in which the town has spread over the very characteristic terraces. The huge smelting works are on the main terrace along the west of the valley, where the road

[1] *Settlement of the Forest and Mining Frontiers*, by A. R. M. Lower and H. A. Innis, Toronto, 1936.

from the Rossland mines reached the Columbia River. The town of Trail is on the lower terrace, with the main street running just above the steep bank of the river. The sketch shows three or four terraces on the opposite bank, of which the lower (1) is largely covered with the houses of East Trail. A suburb has spread still higher to terrace (2), while there are some houses on the small intermediate terrace labelled 1A. The third terrace at a higher level is not so well defined, and is covered with grass. Behind are the rocky slopes of the main valley. This shut-in district is very hot in summer, and many of the workmen live as far away as Castlegar, and drive 20 miles from their work to live in fresher surroundings.

Here as at Ashcroft and elsewhere it seems surprising that the terraces have front edges which are in general parallel to the valley walls, if they have developed by the erosion of the silts of a filled lake basin. In the latter case one would expect crescent-shaped scarps and many meanders and oxbows. Moreover, the silts should show deposition in horizontal beds, whereas I saw much *diagonal* bedding, which seems to indicate that the scarps of the terraces remain much as they were originally deposited, and are not due to large-scale erosion. This diagonal bedding denotes that the material is derived from the adjacent hills rather than brought into the area by the main river (Fig. 69).

The Traverse from Castlegar west to Vancouver

Immediately west of Castlegar the River Columbia expands to the elongated Arrow Lake (Fig. 65). The shores are quite steep, and only a few houses cluster on the infrequent alluvial cones below the tributary gullies. At Deer Park on the east and Dog Creek on the west rather larger deltas have developed. From here the railway climbs 2,500 feet in 20 miles and reaches an elevation of 4,000 feet near Farron. We now descend to Christina Lake, where there are a few small settlements, but Grand Forks is the sole town, with a population of about 1,200. Here the Kettle River flows south through the flat floor of a wide valley, which is farmed largely by Doukhobors. The green paddocks and rows of trees make a pleasing landscape as seen from the train climbing up the western wall. The journey through Midway and Beaverdell ascends high above Lake Okanagan (near Kelowna), and then descends to the south shore of this lake at Penticton. Most of this last section of the railway passes through rather rough forested valleys or along slopes with very little settlement.

Penticton is a thriving fruit-growing town with a population approaching 10,548. It is built on the deltaic flats, which here have filled in the Okanagan valley, and have separated Dog Lake to the south from the main lake north of Penticton (Fig. 65). Lack of

space prevents more than a brief reference to the remarkable terraces near the Government Experimental Farm near Summerland. The main terrace is about 350 feet above the lake, and carries many of the experimental plots. Here also is the manager's house with the finest lawns I have seen in Canada. There are three smaller terraces below the main terrace at about 250 feet, 210 feet, and 140 feet; and Trout Creek has here built a large delta into the lake. There are also three smaller terraces above the Farm at various levels on the slopes high above the tributary creek. One of the lower terraces, consisting of white clay, has been so greatly dissected that it now resembles a series of white pyramids bordering the lake just to the south of Summerland.

The benches on the east side of the lake are devoted to fruit growing, especially apples and peaches; and there are a number of canning factories in the south of Penticton. The rainfall here is only about 9 inches, so that the natural vegetation consists of the ubiquitous sagebrush and cactus. The district was first settled about 1900, largely by British immigrants; but a good many folk from central Europe and some Japanese arrived in later years. The latter were moved inland during the recent war.

Climate and Vegetation of Interior British Columbia

The somewhat unusual topography of the interior of British Columbia results in a specialized climate which has few homoclimes in other parts of the world. This area lies on the boundary of Köppen's Cfb and BSk climatic regions. The sole other part of the world where the topography and climate are somewhat the same is probably to be found some way inland in the south of Chile, which is a pioneer region of little importance to date. Below I give figures for Santiago, which is, however, warmer and wetter in winter. The chief data for Kamloops—on the borders of the Selkirks and the Interior Uplands—may serve as representative of both Canadian regions.

CLIMATE OF KAMLOOPS

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temp. (° F.)	22	27	38	50	58	64	70	68	59	48	36	27	47
Rain (in.)	0·9	0·7	0·3	0·4	0·9	1·3	1·0	1·1	0·9	0·6	0·9	1·5	10·8

CLIMATE OF SANTIAGO, CHILE (*months transposed*)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temp. (° F.)	47	48	54	56	61	65	67	67	63	57	52	48	55
Rain (in.)	3·4	2·4	1·2	0·6	0·2	0·2	0·0	0·1	0·2	0·6	2·3	3·2	14·4

As might be expected, the elevation to a large extent determines the character of the vegetation. Engelmann spruce is the commonest

tree, but some alpine fir and lodgepole pine are to be found in favourable situations. At lower levels throughout the Selkirk area we find the Douglas fir the chief forest tree (Fig. 113). It grows much more slowly than do the trees near the coast, and never reaches such a size. Lodgepole pine is also abundant, especially after fires. Grasslands occupy the bottom-lands, and extend up the lower slopes, especially towards the drier northern portions of our area.

The greater part of the northern Interior Uplands belongs to Halliday's 'Northern Aspen Section'. 'Here well-distributed aspen is mixed with lodgepole pine, Engelmann spruce and scattered Douglas fir. The stands are inclined to be open, and on the river banks black cottonwood appears; while irregular grassy areas occur, especially on the Blackwater' (Halliday, *op. cit.*). For a discussion of the types of agriculture developed in this mountainous area, reference may be made to the map in Fig. 66. This aspect of settlement may be summed up by saying that the Okanagan and Kettle River country is largely engaged in fruit-growing, usually with the aid of irrigation; while the east Kootenay area is rather arid, and here ranching has replaced lumbering as the chief occupation of the settlers. Some description of the important mines will be found in the chapter on that topic.

NATURAL REGION 9: THE FRASER BASIN[1]

As shown on the map in Fig. 65 this region is somewhat of a quadrilateral, with Hope, Jasper, Finlay Forks, and Prince Rupert at the four corners. The area has a general level of about 3,000 feet, but is surrounded by mountains towering to three times that height. Hence it can hardly be termed a plateau, especially as the chief settlements are found in the valleys which are carved across the uplands, often into rather deep glacial troughs. The axis of the region is the famous Caribou Road, which runs from Hope to Quesnel and the goldfields in the Caribou Mountains near Barkerville (Fig. 65). Kamloops is the sole large town, with a population of 8,000, but owing to war conditions Prince George and Prince Rupert have increased largely in importance and may have as many citizens, many of whom were there only 'for the duration'. Quesnel, Lilloet, Ashcroft, and Hazelton are little towns with a population in each case amounting only to a few hundreds. As in the last section, a description of a survey along the main routes, made by the author during two lengthy traverses of the province, will give the reader a fair idea of the geography of the Interior Uplands. It will be convenient to start in the north-west corner at Prince Rupert, and follow the main line of communication from that port to Prince George. Here we turn south along the Caribou Road to Ashcroft, and then proceed to the east along the Thompson River to Kamloops.

[1] Both 'Selkirk' and 'Fraser' regions are names of convenience, rather than structural units.

Prince Rupert and Prince George

When around 1900 the railway to the coast was decided upon, it was necessary to choose the position of the terminal port. A site on Kaien Island (Fig. 73) was found to be the most advantageous. It lay near the mouth of the Skeena River, which was the obvious corridor to the coast. It was well protected from the ocean by Digby Island. The water was deep close to the island and free from ice in the winter. Chief advantage of all, along this fiord coast, there was a considerable area of lowland on the western side of the mountainous island which was suitable for the growth of a city and for the development of truck gardens, &c. It was of course hoped that

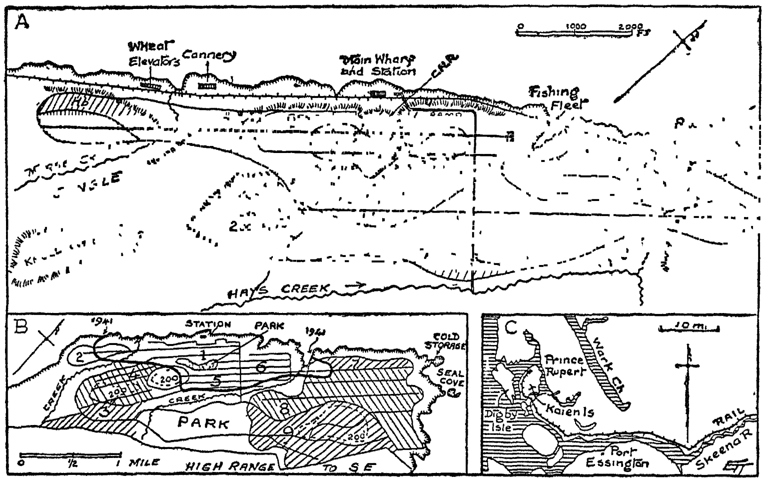


FIG. 73.—Plans of Prince Rupert and the vicinity. A is a functional map, B shows the original plan, only 1, 5, and 6 sections being built. C is a locality plan

the new port would grow like Vancouver, especially as its distance along the Great Circle Route to Japan was about 7 per cent shorter.

In 1906 clearing began, and a Boston firm designed a city plan suitable for the peculiar topography of the site. This development of a pioneer city according to plan is quite rare in North America; and though the city has by no means grown to a population of 50,000 (as assumed in the Boston Plan), yet the little town of 10,400 has benefited from its adherence to the original plan. Prince Rupert has arisen on a rocky ridge running parallel to the coast, which has four 'levels' on its seaward side. First is the shore platform, along which the railway has been constructed. It has been levelled and broadened, especially at the mouth of Hays Creek. Here a powerhouse and a small shipbuilding dock have been erected. Just behind

the station is a small rocky 'step' which carries the offices of the Canadian National Railway. Some 2 miles to the north is a very large cold-storage plant for the important fishery resources of this coast. A fish cannery is operating to the south of the railway station, while some large wheat elevators have a few busy weeks in the fall (Fig. 73).

A few notes on the region as seen from the National Railway (which reached Prince Rupert in 1915) will be of interest. We may take the section (150 miles long) between Telkwa and Vanderhoof (Fig. 65) as being typical. The places mentioned are all railway stations, and there is practically no settlement away from the railway. The whole region is rolling country with rather small coniferous forest. Every few miles is a clearing of ten acres or more, but for the most part the country seems to be untouched by man. There are no mountains visible, and the divide between the Skeena and Fraser Rivers is crossed at about 2,360 feet without any change in the topography. Kitimat and Kemano are described, p. 203.

At Walcott, just to the east of Telkwa, there are less than a dozen houses, and a few acres of grain are all that is visible from the train. Barrett is about the same size. At Houston is a log post office with three large log houses and a number of small shacks. Topley is a bigger town with a number of two-storey houses. Forestdale shows no houses near the station; at Palling a few houses and clearings appear, while at Decker Lake there are five small houses in a wide clearing.

Burns Lake is the local metropolis with a population of 211. There were 202 in 1931 so the growth is not striking. It is the gateway to the new Tweedsmuir Park to the south. Near here we cross into the Fraser River basin. At Tintagel I saw no houses, but at Savory four were visible. Endako has a large hotel and a store and also a large railway yard. About twenty small houses were apparent in the trees to the north-east. Fraser Lake shows a timber-mill, but no houses near the station. Fort Fraser is larger with about 30 houses near the railway. This centre dates back to 1812. Engen has five houses on the south of the line and a large clearing on the north. Vanderhoof is the biggest of these pioneer settlements, with several hotels and stores and perhaps 50 houses near the station (Fig. 65). It had a population of 305 in 1931 which had grown to 342 at the census of 1941.

In the decade following 1910 it was hoped that the Pacific Great Eastern Railway would join the Grand Trunk at Prince George at the junction of the two big rivers (Fig. 65). As is not uncommon there was much rivalry as to the site of the railway station. About 1914 there were three independent centres, each large enough to challenge the other two to hockey matches! These were South

'Fort George' in the south, 'Central' (Fort George) in the west, and modern Prince George in the east. Today (1961) Prince George has a population of 10,500; so that it has grown from 2,479 in the 1931 census. 'Central' now shows two large empty stores and one small active post office. Its population is about a dozen. South Fort George has an empty 'Theatre' building, one large active store, and about a dozen small farm-houses, &c., in the vicinity.

I spent several days in Prince George and received valued help from the agricultural officers of the district. The whole region is covered with soils of great thickness, so that it was necessary to drive about 20 miles to see a roche moutonné of granite near Shelley. These soils are of several types but none is very fertile. According to Mr. Kelley (the pedologist at this centre) in favourable situations a layer of varve-like lake-silt covers many acres. Beneath this is a sandy silt many feet thick, which seems to be a fluvio-glacial deposit. These are the soils which are being carefully surveyed at present, and which are recommended for pioneer farming. Beneath them are thick deposits of pebbly soil (known as Boulder Clay locally), which are harder to work than the others, and are being left in forest growth at present. Then still older in places there is a 'rusty' pre-glacial soil. There are about 3,000 acres in use at present, but about 212,000 acres of fair soil are already available for future pioneers.

Since the region has a rainfall exceeding 19 inches the farmers grow hay, alsike clover, and some wheat and oats. A private creamery seems to be flourishing, and it has opened a branch at Telkwa. The shortness of the summer is the chief handicap to farming. Tomatoes and most fruits find the climate too cold to ripen them. Pigs and other stock do well, but alsike seed is one of the chief cash crops. The railway yards, government positions, and especially building pioneer roads account for much of the apparent prosperity in and around Prince George. (In 1951, 4,703 folk.)

The Caribou Trail, Ashcroft, and Kamloops

From Prince George a good road leads south to Quesnel, where it joins the famous Caribou Trail. Public buses run on alternate days, supplementing the local railway which also covers most of this route. The road was constructed in part by the Royal Engineers in the years 1861–5 in order to enable goods to be transported from Hope to the goldfields near Barkerville (Fig. 65). South of Prince George the road crosses rolling country well to the east of the Fraser River. There are farms every few miles as far as Red Rock (20 miles). Woodpecker has a church, store, and post office; while at Hixon are three or four farms and several acres of grain.

At Canyon Creek is a typical country store which supplies isolated farms and about 100 prospectors. Much gold has been found at

times in the riffles of the Fraser hereabouts. Thick spruce forests bound the road for many miles near Strathnaver, and now the clearings are miles apart. At Cinema (55 miles) is a store with three or four houses hidden amidst the forest. Here the large Cottonwood River flowing from Barkerville is crossed. Within 10 miles of Quesnel, farm clearings become more numerous, with much stooked grain and fields of clover. At Quesnel (70 miles) is the terminus of the P. and G.E. Railway. Its population was 446 in 1931 and is now (1951) 1,587 (Fig. 65).

At Quesnel we reach the Caribou Trail proper, and its historical importance is suggested by the native canoe and the ancient mining pump preserved by the bridge. Kersley is 15 miles south of Quesnel and shows some thriving farms, where considerable areas of beet are grown. Here the rainfall has dropped to 14 inches, and soon the vegetation takes on a xerophytic appearance and cattle ranches alternate with small farms. The road runs close to, but usually high above, the Fraser Canyon for 30 miles as far as Soda Creek, and indeed in places the road is cut into the cliff. *Artemisia* (sagebrush) becomes a common plant. On the numerous terraces just above the Fraser River are a number of small farms. For 20 miles north of Williams Lake the road runs for the most part on a broad, often grassy, bench or plain, several hundred feet above the deep narrow canyon of the Fraser River. Williams Lake is a town of 520 people with a large hotel and several garages.

South of Williams Lake the Caribou Trail and the railway run to the south-east along the broad San José valley. This is about 500 feet higher than the Fraser Canyon, and is diversified by a number of pretty little lakes. There are a number of Indian settlements, but the country is chiefly used for the grazing of cattle, while farms are few and far between. At Lake La Hache (2,700 feet) there is a tourist resort. Near the old 'Hundred Mile House' the road rises to 3,800 feet, and there are numerous ranches in the vicinity. From here the road gradually descends along the Bonaparte valley to the Thompson River at Ashcroft (1,000 feet).

Few settlements in Canada have a more interesting site than Ashcroft, for nowhere are the river terraces which are so marked a feature of the province better shown (Fig. 74). The little town itself is built on the lower terrace about 60 feet above the Thompson River. There is a wider terrace which runs for miles along the valley at a height of about 200 feet above the river. Still higher, about 300 feet up, are the relics of a third and older terrace, which has been dissected into numerous small gullies by the occasional rains.

Some of the terraces exhibit a composite structure, as for instance the sample just south of the bridge on the western slopes. The main Cretaceous rock of the slope is dark, above this comes the

lower inner portion of the dissected terrace formed of yellow silt; while above this again the upper layer is a stony mixture, which carries much more vegetation than the yellow layer. Obviously the condition of deposition has varied a good deal while this terrace was being built. The evidence suggests that some of the terraces are built locally of conjoint fans and debris brought down the adjacent slopes and gullies. Illustrations of these features will be found in the author's description of British Columbia in the *Geographical Review* (New York, July 1942).

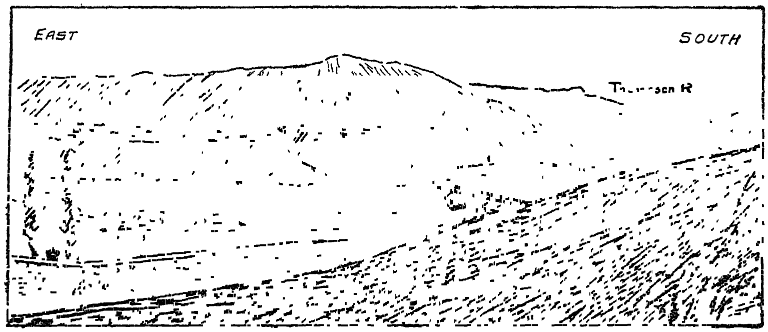


FIG. 74.—Sketch of Ashcroft where the Caribou Road reaches the Thompson River. View south-east across the broad Thompson River. The C.P.R. can be seen across the river; the C.N.R. runs along the west side of the valley, out of sight. Note three terraces, 1, 2, 3

The rainfall at Ashcroft is under 7 inches, hence the natural vegetation on the steep slopes consists of sage-brush, cactus, and allied plants. However, the environment lends itself to irrigation, and pipes from small reservoirs in the hills lead the water to gardens on the terrace lower down. Tomato crops are perhaps the chief close to the town, and these were being canned at the small local factory while I was at Ashcroft. At the north end of the main street were 14 small Chinese shops and houses, but the majority of the 600 population is white—perhaps 200 being Chinese.

Some brief notes on the very varied topography to the east of Ashcroft will be of interest. Near Semlin are many examples of fluvio-glacial terraces along the Thompson River. It is believed that there were several phases of valley glaciation hereabouts, after the waning of the vast Cordilleran Ice-Cap. Since crustal warping occurred in late Miocene and was followed by regional uplift at the beginning and end of the Pleistocene, inevitably a very complex topography results. At Savona the main valley is partly dammed by the very vigorous delta of the tributary Deadman River. Hence the Thompson River is ponded for 20 miles to form Kamloops Lake.

The arid climate near Kamloops is indicated by the universal sage-brush and cactus flora on the shores of the lake (Fig. 65). Here a good deal of irrigation is carried on by long flumes leading water

from higher levels up the North Thompson. The lake rises in the spring and floods the delta at the east end of the lake. Later in the summer these flats give valuable crops of hay. Oligocene lava flows are weathering rapidly and in places give rise to quaint shaped 'hoodoos'.

Kamloops is 250 miles to the north-east of Vancouver, and is situated on the south bank of the Thompson, where it receives the North Thompson (Fig. 65). It was founded as a fur-trading post as long ago as 1812, by Americans coming from the new post at Astoria at the mouth of the Columbia River. Kamloops has a population around 8,000, and is the centre of a large ranching area. The dry climate has led to the development of several large hospitals in the vicinity.

Proceeding to the east we pass the quaintly shaped Lake Shuswap, where two parallel valleys have been over-deepened by glaciers and then linked to form one 'H'-shaped lake (much as has happened at Lake Lucerne). Craigellachie, a few miles to the east near Revelstoke, is where the east and west sections of the Canadian Pacific Railway met in November 1885.

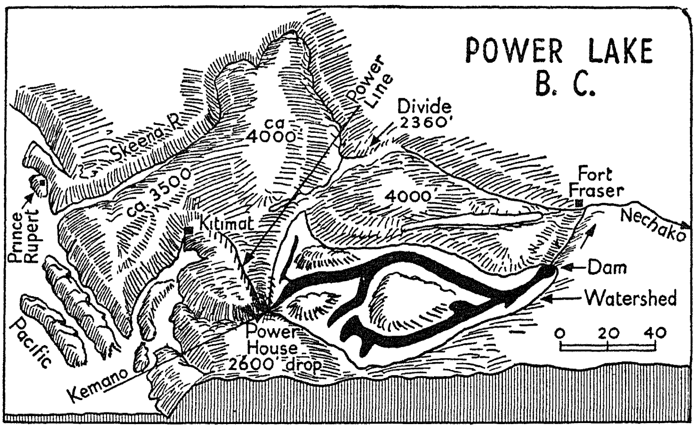


FIG. 74A.—The new aluminium plant at Kitimat, served by power at Kemano based on water from the chain of lakes (shown black)

HYDRO-ELECTRIC POWER AT KITIMAT

A series of elongate lakes in Tweedsmuir Park—some 400 miles north of Vancouver—was originally drained by the Nechako River to the east. A dam on the Nechako 300 feet high links many of the little lakes together (shown black in Fig. 74A) and at the former upper end a tunnel ten miles long drops the water 2,600 feet to the power house at Kemano. From here a high-tension wire carries the power for 50 miles north to Kitimat on the sea, where is a favourable site for a large town. Ultimately it is expected that 1,650,000 horse power can be obtained.

CHAPTER IX

THREE TRANSITION AREAS (NEWFOUNDLAND, THE CLAY-BELTS, PEACE RIVER)

NATURAL REGION 10: NEWFOUNDLAND

History of Newfoundland

IT is somewhat difficult to know where to place a brief account of Newfoundland. The island joined the Dominion on April 1st 1949, and its great dependency of Labrador is part of the mainland of North America. Most of the connexions of these areas are naturally with the adjacent provinces of the Maritimes and Quebec. Perhaps the present position in this chapter, before we take up the study of the sparsely settled transition areas of the Dominion, is as logical as any other.

The area of Newfoundland is 42,734 square miles, and the population in 1951 was 361,416. Hence the density of population is about 7 per square mile, i.e. exactly the same as that of Ontario. As in the latter province, the population is concentrated in certain rather small areas, while much of the country is uninhabited. Only in the east, in or near the peninsula of Avalon, does the density approach 20 per square mile. The last map in Fig. 75 shows by dots almost every town with a population over 1,000 persons, so that it is clear that the northern peninsula, the south centre, and the south (inland) are practically uninhabited. These areas contain no roads, and the sole access is by sea to innumerable coastal villages.[1]

Cabot discovered the island, probably at Cape Bonavista, in 1497, and in a very few years the remarkable abundance of fish attracted boats from Europe, especially from France, Portugal, and Spain. In 1550 one Portuguese port alone sent 150 vessels to Newfoundland. The Basques took a great interest in the region after about 1550, especially in hunting seals and whales; and the chief port in the south-west is still named Port aux Basques. The voyages of Cartier in 1534, 1535, and 1541 established the major claims of France to all these lands. About 1690 they took measures to prevent the Biscayans and Spanish from catching fish in the adjacent waters.

English vessels had long frequented the Banks, and in 1578 there

[1] A useful summary of conditions in Newfoundland—especially as regards surveys—is given by J. E. Rothery in the *Geographical Review*, New York, for October 1933. The name is pronounced *Nee-oŏfn-land.*

were fifty English vessels engaged in the Newfoundland trade. This was the year of Sir Humphrey Gilbert's first voyage, and in 1583 he took possession of the island for England in spite of the French claims. In 1593 Richard Strange had his headquarters for this prosperous trade in fish at Ramea on the Gulf of St. Lawrence (D. W. Prowse, *History of Newfoundland*, 1895).

John Guy made some attempts to explore the region in 1612, and was on friendly terms with the Beothuk Indians. He built a small settlement at Cuper's Cove (now Cupids) to the west of St. John's. This was soon abandoned, but a more ambitious attempt by Sir George Calvert at Ferryland south of St. John's in 1621 had more success. Here Kirke some years later made his home, and for fifty years some attempts at settling the colony continued. But the fishing trade fell wholly into the hands of wealthy merchants of the West of England, and they succeeded in maintaining a fishing monopoly; and opposed all real settlement which would tend to remove complete control from their hands.

The French long disputed the claims of the English, but their claims were disallowed at the Treaty of Utrecht in 1713, except as regards the small islands of St. Pierre and Miquelon. In 1729 a Governor was appointed from England who found great difficulty in reducing the power of the 'Fishing Admirals', as those who controlled the old monopoly were called. It was not till about 1802 that the restrictions on settlement in the interior were to a considerable extent removed. In 1833 the first parliament met, and this continued in control until the Great Depression in 1930. In 1934 it was decided to govern the country by a Commission of three Englishmen and three Newfoundlanders, and the finances were very greatly helped by subsidies from England.

The Build, Geology, and Mines of Newfoundland

The geographical position of Newfoundland gives it a peculiar importance in our study of the development of Canada. It lies right across the approaches to the Gulf of St. Lawrence; and is separated by only 70 miles from Cape Breton, and by 12 miles from the mainland at the Straits of Belle Isle. Indeed, the eastern cape is only 1,640 miles from Ireland, and this explains its unique value in regard to air-lines between Britain and America.

The build of the island is relatively simple, and in turn explains the varied outline with the immense number of large and small peninsulas. In general it seems to be an extension of the Acadian Folds of Nova Scotia. Granites and allied Pre-Cambrian rocks form the basement of the island, and indeed form the surface rocks in about half of its extent. There is, however, a considerable difference in the facies of these ancient rocks in the east and west, which is

worth a brief consideration. Granites and gneisses are almost universal in the west, as near St. George's Bay, where they are like those of the Grenville series in Ontario. Some valuable minerals, such as magnetite, graphite, and molybdenum, are associated with these granites. The old rocks of the Avalon Peninsula in the east contain many volcanic series, as well as slates and quartzites. Lead, barite, iron, and gold are found in small amounts in this sequence.

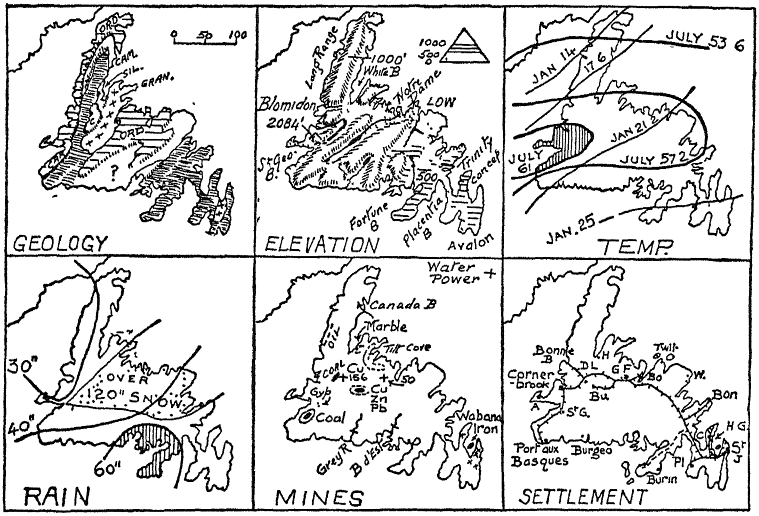


FIG. 75.—Six maps showing the main geographical features of Newfoundland. Long Range Plateau rises to 2,666 feet

Cambrian rocks occur in the Long Range Plateau of the north-west, and are indicated on the sketch map. They contain some marble, but otherwise seem to have no economic value. Cambrian beds are also found in the Avalon Peninsula. The dominant sedimentary formation is the Ordovician, which covers a large part of the centre and west coast. These beds are two or three miles thick in the west and centre, the latter being dominantly volcanic. Lead and petroleum are associated with the western Ordovician rocks; while the Upper Ordovician shales, &c., of Avalon contain the chief mineral deposit of Newfoundland, i.e. the extremely important Wabana iron ores.

The centre of the island contains many formations which seem to be lower Paleozoic, but whose exact position in the geological record is not yet known. They are classed with the Ordovician in Fig. 75. A syncline, cutting off the north-west and Long Range, is filled with Carboniferous rocks, of some importance as sources of minerals. Near the Bay of St. George gypsum is found in beds of this age.

Somewhat later rocks in this area contain coal-beds, which are also found at Deer Lake (see map on p. 215).

There are no formations later than the Carboniferous, except the extensive glacial deposits laid down in the Pleistocene. Few regions in the world show the effects of the removal of the great load of ice better than Newfoundland. A 'hinge-line' (of no movement) extends along the southern hinterland from west to east. To the north of this hinge the island has risen at about 2½ feet a mile as we proceed northwards. Thus near Belle Isle, coasts which were at sea-level during the Ice Ages, are said to be 500 feet above sea level today, as the crust has reached equilibrium after the removal of the immense weight of ice.

Mining has an importance in Newfoundland much greater than that of agriculture, and its development may be briefly considered here. The copper-mines of Tilt Cove—about the centre of the north coast—were the first developed on a fairly large scale (fifth map in Fig. 75). These gave dividends of 5 million dollars from 1888 to 1912. The immense Wabana iron deposits were discovered about 1892 on Bell Island only 15 miles west of St. John's, but these mines will be discussed in the chapter on mining later in the book (p. 433). Buchan's River ores were discovered in 1905, but not much work was done there till 1928, when the flotation process was found to suit the complex lead-zinc-copper ores. The coal in the south-west was mined for a time after 1919, but the seams were found to be thin or faulted, and not much has been won in consequence in this district. Fluorspar on Burin Peninsula is now being mined to a considerable extent. A little manganese is mined in Avalon Peninsula near Trepassy and elsewhere. Molybdenum is present on the south coast, but not much mining has been done.

Many non-metallic minerals of value occur in the island, but none is of outstanding value. Asbestos is worked at Bluff Head on the south-west coast. Coal occurs at two localities, i.e. the south side of St. George's Bay and at the north end of Grand Lake. In both cases only remnants of former synclines seem to be preserved. Nine coal-seams occur in the syncline just east of St. George's Bay. One seam is four feet thick and of a good quality. The Humber coal syncline near Grand Lake is about 12 miles long. It is estimated that there are about 500 million tons available in these coalfields (A. K. Snelgrove, *Mineral Resources*, St. John's, 1938). The oil shales near Grand Lake and Deer Lake have yielded small supplies of oil, but they do not compare in value with the Scottish oil-shales. Petroleum seepages occur on the west coast, but no supplies of note have yet been discovered, though in 1907–8 900 barrels were shipped from Parson's Pond to St. John's. At Canada Bay on the east coast of the Long Range white and blue marble has been quarried for

some time. A summary of the mineral production since 1854 shows a total value of 91 million dollars. Of this amount just half is due to the iron ore from Wabana, while nearly all the rest is due to copper ores from the north, or to the lead-zinc-copper ores of Buchan's mine east of Grand Lake.

A glance at the geological map (Fig. 75) shows us that we are dealing with a portion of the Shield which has been slightly corrugated during the various mountain-building operations in this part of the North American continent. Apparently the crust hereabouts was squeezed between resistant areas north-west and south-east of the island, and so a series of synclines and anticlines was formed at right-angles to the folding forces. As usual, the tops of the anticlines have tended to be removed by erosion, while the former surface rocks are better preserved in the synclines. Thus along the depression which extends between White Bay and the Bay of St. George we have a district which contains the youngest (Carboniferous) rocks of the island. The drowned ends of these synclines account for the numerous gulfs running in the direction mentioned above. The promontories are the ends of the upfolded portions, and consist generally of somewhat older rocks. This is the case in the several promontories in the east which build the peninsula of Avalon (see second map in Fig. 75). In the Long Range in the north-west we seem to see a dipping anticline, with the oldest rocks appearing in the higher southern portions.

The coasts are often cliffed for a height of 200 or more feet, but the interior is on the whole an undulating low plateau with a general level of about 1,000 feet. The highest point in the island is Lewis Hill (2,673 feet) on the south-west coast, though Long Range may have heights of about the same figure. In Avalon none of the summits reaches much above 1,100 feet. There are three fairly long rivers, which are indicated on the map giving the elevations. In the west is the Humber, which drains Grand Lake as well as the adjacent Deer Lake. It curves to the west and enters the sea near Mt. Blomidon. The largest of the three is Exploits River, which drains Red Indian Lake and then flows north-east to Notre Dame Bay. The third (Gander River) drains Gander Lake, and enters the sea to the east of Notre Dame Bay. At Grand Falls on the longest of these rivers is situated one of the largest pulp-mills in the island. It is marked as 'G.F.' on the last map (Fig. 75).

Newfoundland is naturally well endowed as regards hydro-electric power, since it has experienced considerable elevation, has a good rainfall, and (for Canada) not a very cold winter. Twelve sites in the island have been developed, giving a total of 221,000 h.p., and nearly all are capable of expansion. Six of these sites are on Avalon Peninsula, but much the most important are in the west

centre of the island and are shown on the Mines map (Fig. 75). On Deer Lake 156,000 h.p. has been developed, while close by to the east is another of 2,000 h.p. at Buchan's. Near Grand Falls 50,000 and 11,000 h.p. are in use. The best sites for future use are on the south coast at Bay d'Est (250,000) and Grey River (100,000 h.p.).

Climate and Vegetation of Newfoundland

The climate of Newfoundland is more continental than one would expect from its position off the coast of the continent. The range of temperature is about 40° F., which can only be matched in similar

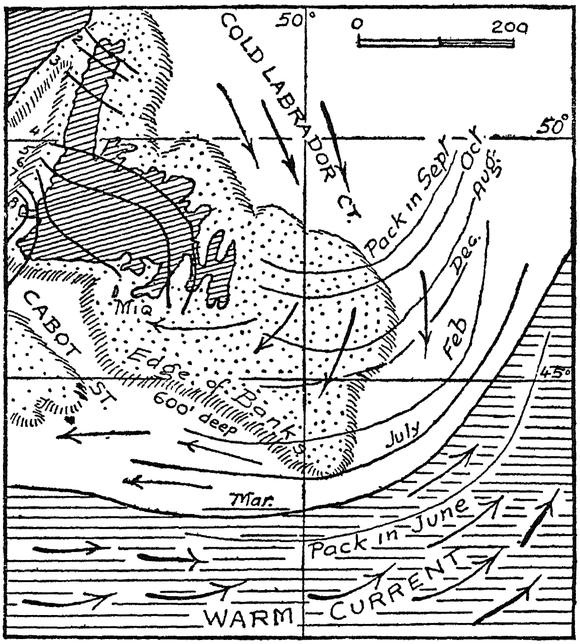


FIG. 76.—Currents and Pack Ice off Newfoundland (after Schott). The lines indicate tree limits (after R. Bell). 1, paper birch; 2, pyrus; 3, aspen; 4, white pine; 5, yellow birch; 6, ash; 7, elm; 8, maple

latitudes by Hokkaido, the northern island of Japan. This is due to the general drift of the air being from the continent, while the oceanic waters are particularly cold hereabouts owing to the cool Labrador current, which bathes the shores of Newfoundland (Fig. 76).

There is a difference of 12° F. between the temperatures of the north and south of the island in January; but in summer, as the

third map in Fig. 75 shows clearly, it is the west which is the hottest part of the island. The course of the 57° isotherm in July is shown, and this seems to indicate that agriculture must be confined for the most part to the lowlands with fair soil in the west (and perhaps in the east) of the island. As a matter of fact, much of the agriculture of note is to be found in the Codroy Valley in the far south-west.

The rainfall is satisfactory enough from the point of view of power and crops, being 60 inches along the south coast where hydro-electric power will develop, and about 36 inches in the south-west farming district. The least rain occurs along the west coast of Long Range, where it has diminished to 30 inches. There is not much variation from season to season at St. John's, but in the north there is a slight summer maximum. However, Port aux Basques shows a mixture of winter and summer rain. In general the winters are mild, but the summers are very short. It is interesting to compare this region with Victoria (B.C.) where the winters are 15 degrees warmer. The rains are spread through the year in such a fashion that some rain falls on about half the days of the year. The east centre of the island has the very heavy snowfall of over 120 inches, thus ranking with the hinterland of the city of Quebec as the heaviest in the east of North America.

There seems to be only one portion of the world which can be described as a homoclime of Newfoundland, and that is Hakodate (or Sakhalin) in North Japan. In Fig. 77 are given the hythergraphs for St. John's and Belle Isle in the island and for Hebron in Labrador. For comparison I show the graph for Hakodate, and also the 'Comfort Frame' (see p. 120). It will be seen that all these places, especially Belle Isle and Hebron, are largely in the regions which are too cold and damp for comfort.

There is one feature of the climate which is very important and that is due to the remarkable character of the adjacent oceanic waters. Nowhere else in the world is the change of temperature in the sea more rapid than near the Banks of Newfoundland. In Fig. 76 the usual position of the warm waters moving up the coast of U.S.A. is shown. This is in a sense an extension of the Gulf Stream, but is mainly due to the prevalent south-west winds in these latitudes. From the north sweeps down the cold water of the Labrador Current, which curves over the Banks and to some extent enters Cabot Strait. This latter current brings down large masses of pack ice, whose southern margin varies with the season as shown in Fig. 76. Thus it is farthest south in June, when the ice soon melts away, while its most northern position is found in September to the east of the peninsula of Avalon. The shallow seas and the plentiful pelagic life associated with such cold currents, account in large part for the extraordinary abundance of fish on the Grand Banks.

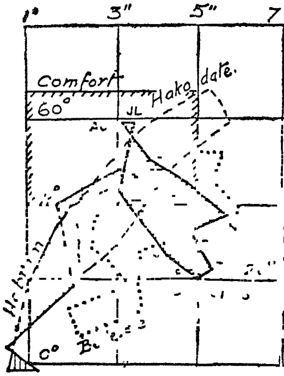


Fig. 77.

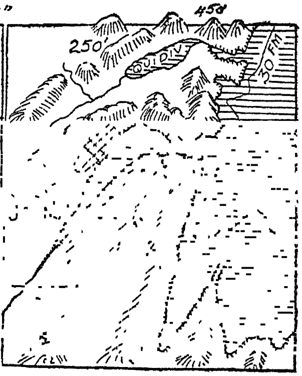


Fig. 78.

FIG. 77.—Hythergraphs for St. John's, Belle Isle, and Hebron (Lab.); with Hakodate, Japan, for comparison. The 'Comfort Frame' is added

FIG. 78.—Sketch of the Harbour of St. John's, showing an early stage of the city (after Prouse)

Fog is such an important feature in the life of eastern Newfoundland that some attention must be given to it here. According to world cloud maps it shares with south-west Alaska the record of the cloudiest skies in North America. This is, of course, due to the peculiar temperature conditions already described. Here, especially in the summer, we find masses of warm moist air from the Gulf Stream (and its extension, shown in Fig. 76) passing over the denser wedge of cold air coming from the north. The following table of *Frequency of Fog* is taken from a valuable memoir on Weather by W. E. K. Middleton (Ottawa, 1935).

FOGS NEAR NEWFOUNDLAND
(*Days per month*)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	**Total**
Cape Race	13	9	8	14	19	22	26	22	16	15	13	12	188
Yarmouth (N.S.)	3	3	5	4	6	9	14	12	8	4	3	2	74
Port aux Basques	1	1	3	3	7	8	11	6	4	3	2	1	49
St. John's	0	0	2	3	4	1	0	1	0	1	1	0	13

At Cape Race, which has the worst record of all for 'Thick Weather', the morning from 4 a.m. till noon in July is the worst time of the year. In winter the thick weather is not so prevalent in the morning, since it is often due to snow. In most cases the fog occurs with south winds, as we should expect. Calms are often associated with fog in summer, but not to the same extent in winter. Middleton states that on the Atlantic Coast a fog will generally

terminate with the arrival of a 'cold front'. It is in early summer that the sea is much colder than the air above it, hence the prevalence of fogs. At Montreal the land is of course cooler than the air in winter, hence February is the foggiest month here, while June and July are the clearest months.

Newfoundland exhibits a crowding of the types of trees which are found in the adjacent mainland. According to R. Bell (*Scot. Geog. Mag.*, 1897) the zones are so arranged that only the colder, northern, genera are found along the north-east coast, and the most southern types only in the south-west corner (Fig. 76). These tree-zones run as follows:—Paper birch extends right to the northern coasts. Aspen does not quite reach the north coast, but is found throughout the interior. White pine is not quite so tolerant of the cool conditions of the north-east. The yellow birch occurs throughout the centre and south-west, while the ash, maple, and elm are confined to the warm south-west corner only.

These zones of well-grown trees are found mainly in the lower portions of the island. The flattish summits of the ridges bear a flora akin to that of the Tundra. Here grow shrubby berry-bushes and dwarfed birches. There do not seem to be any genuine 'Savanas' in the opinion of Hans Schrepfer.[1] He believes that the open spaces are mainly due to forest fires. The white pine has nearly all been cut down, and he states that two pulp-mills at Grand Falls and Corner Brook had removed 2,400 sq. km. of good timber by 1935. The commonest trees in most of the island are the spruces, though in the west the balsam fir is perhaps more abundant.

Settlement and Agriculture

The total population of Newfoundland is about 438,000, but it is dispersed in a great number of small communities, and apart from St. John's there is no really large town. Even the capital has only about 57,000 citizens, which is a small number for the 'oldest colony in the British Empire'. St. John's has grown around a rock-bound harbour with a narrow entrance between two rocky hills. On the north is Signal Hill (520 feet), and on the south above the light-house the cliff rises to 600 feet. The entrance is only 600 feet wide, and formerly was barred by a chain. The harbour proper is clearly the drowned portion of one of the numerous parallel valleys, some of which are apparent in the sketch map (Fig. 78). The harbour is a mile long, with the town spreading over the slopes to the west of the harbour.

It was founded about 1580, starting as a collection of fishermen's huts. It has been devastated by two great fires, in 1846 and 1892. A dry-dock was built at the head of the harbour in 1884. Nearby

[1] *Ergebnisse geographische beobachtungen in Neufundland*, Frankfurt, 1936.

is a small lake in one of the parallel valleys, called Quidividi, which is about half a mile long. The town has grown greatly of late, since thousands of American troops were stationed in the vicinity after 1940. It contains two cathedrals, and most of the citizens are of Roman Catholic faith. It is the centre for the fishing and sealing trade, and the terminus of the numerous coastal steamers. Oceanic lines connect with Liverpool, New York, Halifax, &c.

The other towns are quite small, the chief being: Cornerbrook (23,000 folk), Grand Falls (4,500), Bonavista (4,200), Carbonear (3,400), Twillingate (3,400), and Harbour Grace (2,300) (Fig. 75). The railways started about 1881, and Harbour Grace was connected to the capital by 1884. The connexion to Port aux Basques was not completed till 1898. Cornerbrook was a quiet little village until 1923, when British capital arranged to build a paper-mill, supplied with power from Deer Lake 32 miles to the east (Fig. 77A). To ensure the water-supply in Deer Lake, a dam was built which raised the level of the adjacent Grand Lake by 30 feet,[1] and a 7-mile canal cut to lead this water into Deer Lake. At the power-house on Deer Lake the water has a drop of 250 feet. From Corner Brook special steamers carry over 5,000 tons of paper to New York and other American ports. Around 1931 there were some 4,000 people engaged in the work of this huge paper company.

In 1907 the waters of Grand Falls were harnessed, and Lord Northcliffe opened the large paper-mill at that place in 1909. A special railway was built to Botwood 22 miles to the north, where the paper is shipped to England. Some mention must be made of the 28 submarine cables which link Newfoundland to the rest of the world. The first across the Atlantic was laid from Heart's Content in 1858. Others leave from Placentia, and several from St. John's.

No mention so far has been made of the agricultural resources, and in truth there is little to be said. From a consideration of the 57° F. isotherm in July (Fig. 75) one can see that very little of the country is warm enough for large-scale grain-growing. The distribution of the trees given in Fig. 76 shows that it is too cold for the trees (and crops) of southern Ontario to flourish. Indeed in 1938–9 the island imported $1\frac{1}{2}$ million dollars' worth of flour, and over a million dollars' worth of salt beef and salt pork.

No better example of the influence of structure and climate in deciding the possibilities of a land can be seen than that offered by a comparison of Newfoundland with its near neighbour Prince Edward Island. This latter province is only 160 miles to the south-west, yet it exhibits the densest farming in the Dominion. About 50 per cent of the whole area has been converted into croplands and the density of population is 44 to the square mile. In New-

[1] J. R. Smallwood, *The New Newfoundland*, New York, 1931.

foundland less than half of one per cent is said to be cultivated, and the interior is empty, except for the settlements near the Grand Falls paper-mills, the Deer Lake Power Station, and the mine at Buchans (Fig. 77A).

In Prince Edward Island we see a lowland region formed of fairly *young* (Permian) rocks, which give rise to fertile soils. The average temperature in July is 66° F., i.e. much warmer than the critical temperature of 57° F. discussed elsewhere. In Newfoundland we are dealing with a tilted plateau, about 1,800 feet high in the west and about 800 feet high in the Avalon Peninsula in the east. It consists essentially of ancient granites, gneisses, or Ordovician formations, all of which produce distinctly sterile soils. The average July temperature is about 56° F.; and the summer is too cold to suit the bacteria, worms, and other organisms which change peat, leaf-litter, &c., into humus suitable for plant-food.

The writer made a reconnaissance of Newfoundland during the summer of 1945 with a view to estimating the possibilities of agricultural settlement. He was much impressed by the new vigour which obtains in opening up the inland areas. Detailed topographic maps are now being published, and some aerial surveys are being carried out. A large experimental farm is training young farmers scientifically near St. John's. Best of all, the most promising areas are being systematically surveyed by expert soil scientists, and detailed maps of the soil distributions are being made available to the new settlers.

Much of Avalon has a summer like that of central and northern Finland, or of the lower mountain slopes in the centre of Sweden. These are not of much importance agriculturally, even with the dense populations living close to the south. Hence we must not expect much from the greater part of Newfoundland. A hay-potato-dairy economy seems to be indicated for most of the lowlands, except perhaps in two very interesting regions in the west of the island, where the structure is quite different from that found in most of Newfoundland.

In the far south-west is a small area of lowland known as the Codroy valley. It has the appearance of a triangular *graben*, lying between the Anguille Plateau on the west and the main Newfoundland Plateau on the east. It is about 8 miles wide, and is drained by the Great and Little Codroy Rivers. Here is a considerable area of Carboniferous rocks, i.e. much younger than most rocks in the island. There are about 2,000 settlers, in part depending on farming, in part on fishing. The railway runs down the valley to Port aux Basques, where this entrepôt town of 2,000 could absorb much more produce from the Codroy valley (some 15 miles west) than is now consumed there (see last map in Fig. 75).

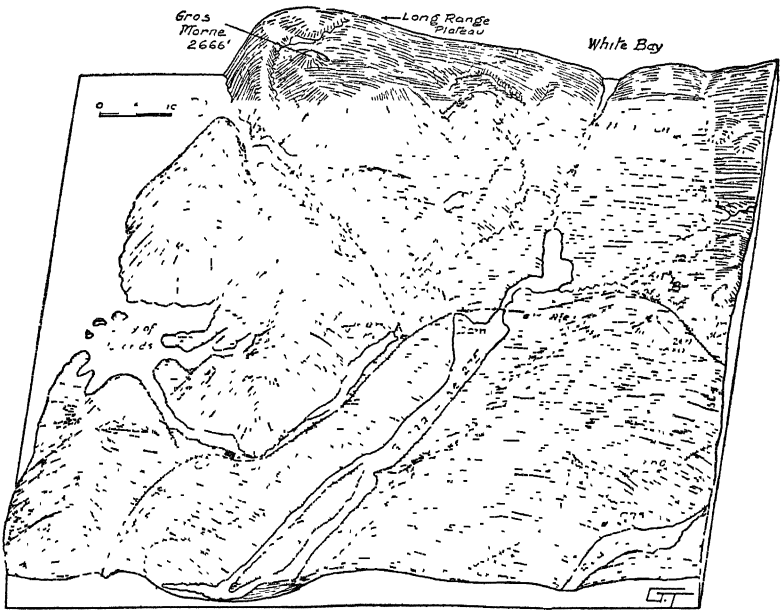


FIG. 77A.—Block Diagram of the lowland (*graben*) of the Humber basin, showing the elevated Long Range Plateau in the west, cut through by the Humber River in a gorge near Humbermouth (H.). Notice the area where the new farms are being cleared in the forest, and the site of Cornerbrook with its huge paper-mills, the second town in the island

The second area is much more extensive, and comprises the middle and upper Humber basin to the north-east of Cornerbrook. The main features of this region can be understood best by reference to the block diagram (Fig. 77A); which shows the topography between the central plateau at Maintopsail and the Bay of Islands. At Maintopsail are three very striking monadnocks, which stand up like giant 'thumbs', about 200 or 300 feet above the main plateau. They are undoubtedly relics of a bygone early peneplain, for many similar monadnocks occur elsewhere on the plateau.[1] The railway now descends along Kitty's Brook, where is a series of small lakes separated by five elongate mounds resembling terminal moraines. Howley is soon reached, which is a large village inhabited by the families of loggers engaged in the forests to procure logs for Cornerbrook Mill.

[1] The best study of the topography of the island is that by Twenhofel and MacClintock, 'Surface of Newfoundland', *Bull. Geol. Soc. Amer.*, Vol. 51, pp. 1665–1728, New York, 1940. The present writer has published a fairly full account of the topography and settlement of Newfoundland in a small book, *Newfoundland*, Toronto, 1946.

Grand Lake has been greatly increased in volume by means of various dams, so as to give a greater head of water to the power-house at Deer Lake. Here also is a village of loggers' families, containing a hundred houses and two churches. But the chief interest to the geographer is found about 10 miles to the north along the road to Bonne Bay. Here the writer saw the soil-survey of the dense forest-land being carried out, followed in other parts of the Veteran Settlement Area by clearing operations in a number of 10-acre blocks. It is expected that the men will obtain part-time employment as loggers (in the adjacent forests) for Bowater's Mill at Cornerbrook.

This rather large lowland area between Deer Lake and White Bay is another *graben* in all probability; and its surface consists essentially of soils derived from Carboniferous rocks, much like those in the Codroy area. Deep glacial and fluvio-glacial soils can be found in many parts of the *graben*; but it cannot be said that they offer much in the way of plant food. A long and laborious process of humus-building, by way of crop rotation, legumes for nitrates, and animal manuring is indicated before this becomes a flourishing farming section.

There is a number of old-established farms along the low terrace-like shores of Deer Lake (F.F. in Fig. 77A). Here is perhaps the warmest district in the island, and pumpkins and maize usually ripen in some of the farms. Many acres of potatoes are being grown; and beets, turnips, and oats all do well, if supplied with fertilizer. The total production of vegetables for the island in 1943 is as follows: 100,000 barrels of turnips, 700,000 barrels of potatoes, 10,000 barrels of carrots, and 3,300 barrels of beets; as well as 80,000 tons of hay. Such crops were estimated to be worth about 6 million dollars; while the livestock on the island (including 25,000 cattle) was valued at 7 million dollars.

Continuing our traverse to the west along Deer Lake, which is only 12 feet above sea level, we reach the striking Humber Gorge at the western end of the lake. Here the Humber River cuts through the plateau, which rises nearly 1,500 feet above it on the north. It appears as if the river has cut an antecedent gorge in a rising *horst*, forming Long Range. It enters the Bay of Islands at Humbermouth, which is a railway division town with several engineering and repair shops. Adjacent is Cornerbrook with about 10,000 inhabitants, which is the second town in Newfoundland.

Bowater's Mill at this site controls about half the timber in the island, i.e. that growing in the Humber basin, the Gander basin, as well as a large area in the north-west peninsula. (Most of the rest is controlled by the Grand Falls Company, mainly in the Exploits basin.) Paper production at Cornerbrook is about 665 tons

of newsprint and 130 tons of sulphite pulp daily. The product is exported in the company's six steamers, though in winter, when the port is frozen, the paper is carried by train through the Codroy valley to Port aux Basques about 150 miles to the south.

The average fisherman is also a farmer, that is to say that while he is primarily dependent on the sea, he also cultivates a small strip of land in the neighbourhood of his house. This farm is little more than an allotment supplying the family with potatoes and other vegetables, and it sometimes supports a few sheep or goats.[1]

As far back as 1891 the farm produce of the island was worth about 1½ million dollars, of which 80 per cent consisted of hay and potatoes. Probably the proportion of the whole today is somewhat the same. It is stated that today (1943) the amount of land under cultivation is about 110,000 acres, or little more than one-third of an acre for each person (*Newfoundland*, Saunders and Back, Toronto, 1943).

The comparative importance of fisheries and agriculture may be gauged from the statistics for 1935, when there were 35,000 men engaged in the cod fishery and only 4,226 farmers. About this time there were 22,000 cattle and 94,000 sheep on the island. The total value of all crops harvested for 1937 was 3½ million dollars, of which almost the whole was used locally. The very important fishing industry is described in the note appended to page 233 ; while the Wabana deposits of iron ore are discussed under Mining (p. 433).

NATURAL REGION II : THE CLAY BELT

When the settlers in Upper Canada to the north of Lake Ontario had occupied most of the lands near the great lakes, they began to expand northwards into the region of the Canadian Shield. It was soon obvious that quite poor soils were characteristic of this enormous division of the Dominion. However, some 200 miles north of the farms on the lake shores, and about 150 miles north of the southern edge of the Shield the character of the soils changed quite considerably, and the sterile granite soils gave place to enormous areas of almost white clay interspersed with much peaty material (Fig. 79). It was felt that this was a much more promising field for agriculture than the normal Shield, and about 1910 many farms were taken up in the 'Clay Belt' as it came to be called.[2]

On the old rock surface of the Shield have been deposited quantities of glacial lacustrine clays in the south, and clayey till in

[1] *Royal Commission on Newfoundland, 1933*, London, 1934.

[2] The best accounts of the Clay Belt from the geographical point of view are by J. R. Randall in *Scot. Geog. Mag.*, January 1940 ; and in *Geog. Soc. of Philadelphia*, October 1937. See also "Pedology" by G. A. Hills, *Canad. Geog. Jnl.*, 1944, for soil data of the region. *Settlement and the Forest Frontier*, A. R. M. Lower, 1936, is valuable also.

the north, producing a level to gently rolling plain, broken occasionally by rocky hills and promontories of the surrounding Shield. Streams are abundant and form a close-meshed net, and these have cut steep-sided valleys in the glacial deposits. Where the crystalline bedrock is exposed, falls and rapids are commonly formed. In shallow depressions, especially on the flat divides, swamps have formed and are generally of the muskeg type. Lakes of glacial origin are also very common. Many of the streams and swamps are all but hidden by forest, which originally covered most of the Clay Belt. Predominantly coniferous, the forest is dense, with a majority of its trees small to medium in size. Beneath the trees is an understorey of shrubs, plants, and mosses that adds to the density of

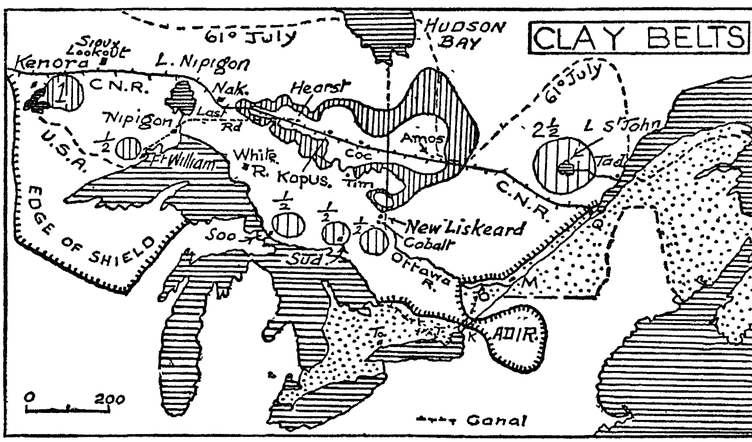


FIG. 79.—Map of the Clay Belts (vertical ruling) and the adjacent Shield The figures give the approximate areas in million acres. Note the last link in the roads of the Dominion between Nipigon and Hearst. (The better portion of the main clay belt is left blank, and this portion is based on a survey by G. A. Hills)

growth. Black spruce and balsam are the major coniferous species; aspen and white birch, the chief representatives of the hardwoods (Randall, *op. cit.*).

Later investigation of this region of clay soils has shown that the area of 40,000 square miles, though better adapted for agriculture than the remainder of the Shield, is by no means an easy field of settlement (Fig. 79). It has one advantage, and that is its proximity to the rich mines of Sudbury, Timmins, Kirkland Lake, and Rouyn. The great difficulty in a pioneer region is to market the crops produced there. Transport costs usually swallow up all the profits, especially if the goods are perishable like milk, potatoes, and vegetables. The second asset is the presence of valuable forests in the

vicinity, which have led to the development of great paper- and pulp-mills. These not only require much labour, which the settlers can offer, but the mills also accept the pulp-logs, which the prospective farmer must cut off his land, as sources of pulp and paper. Thus there is a mixed economy in the Clay Belt, and this is the best argument that this region will endure as a valuable crop area.

The first step in our discussion must therefore be to learn the limits of the clay soils, of the mining fields and of the pulp-producing forests. The area of forests which is involved in the paper-pulp industry lies almost wholly south of the Canadian National Railway from Kenora to Quebec, shown on Fig. 79. These ' pulp-forests ', as utilized at present, are almost wholly on the Shield, so that the pulp region involved lies north of the Great Lakes and the lower St. Lawrence except for a small area in the ' Eastern Townships ' of Quebec (Fig. 117).

The great mining fields near the common border of Ontario and Quebec cover a much smaller area. They are shown on Fig. 79 by the initials of some of the mines, which are Timmins, Kirkland Lake, and Sudbury in Ontario (with Cobalt, which is now much reduced in importance), and Rouyn in adjacent Quebec. As the simplified map suggests, these valuable ore deposits have been discovered in the *higher* land, where the rocks of the Shield project like islands or promontories above the lower, nearly level, clay-silts, &c.

The Clay Belt itself represents the fine silt laid down in a former glacial lake, which has been called ' Lake Ojibway '. The general slope of the land is towards Hudson Bay, and when this northern region was covered with several thousand feet of ice, as occurred at the close of the Ice Ages, the water to the north of the river divide (i.e. Height of Land) was ponded by the ice into a lake of the same type as is illustrated in the sketch of Lake Agassiz (Fig. 58). Needless to say, there are many other smaller ' pockets ' of similar silts scattered over the Shield ; and some of the larger of these near Cobalt, Sudbury, Fort William, and Kenora, are shown in Fig. 79. Another feature of interest in the map is the road which links Nipigon to Hearst. This was built in 1943, and is the last link in the Trans-continental Road between Tadoussac (TAD.) or, if one prefers, Cape Breton, and Vancouver (see p. 147).

The southern edge of the main clay belt as shown in Fig. 79, agrees fairly closely with the 1,000 feet contour above sea level. The so-called ' Height of Land ' is generally only about 60 miles north of Lake Superior, though Lake Nipigon is enclosed by a northern loop in this main river divide. No portion of this large region reaches the 1,500 feet contour. Most of the pulp-mills are to be found where the divide is far south and the rivers drain *north* to the Canadian National Railway ; for in these streams the logs

can readily be floated down to the mills, and the pulp, &c., shipped out by rail. In the future the region north of the railway will be exploited, but here in the colder climate the timber is not quite so suitable for paper production (Plate II).

Climate and Soils of the Clay Belt

As regards climate, this Clay Belt Region (which covers a somewhat larger extent than the actual Clay Belt, as shown in Fig. 79) does not differ much from the data already given for Fort William and other districts near Lake Superior. Kapuskasing (just north of Timmins) may be taken as fairly typical. Here is one of the largest paper-mills, and the workmen live in an interesting 'Company Town' especially built for their use. The July average is 61° F., and for January the figure is − 3° F., giving a range of 64° F. The total rainfall is about 25 inches, of which about 8 inches falls as snow. There is a well-defined maximum in late summer, September receiving 3·5 and July 3·2 inches of rain. This indeed is one of the chief drawbacks of the region as a crop producer since the period of harvest is apt to be wet.

Randall discusses the climatic conditions in his memoir, as follows. The shortness of the frost-free season and the rather heavy late summer and early autumn rains are the principal handicaps of the farmer. The average frost-free season at best is short, but perhaps more critical than its length is its variability from year to year. The eastern part of the Clay Belt averages about 100 days, and the western about 60 days, free from frost. In the south the period is about 112 days. At Haileybury (with a record of 29 years) July is the only month in which temperatures below 32° F. have not been recorded. Thus not only are numerous middle-latitude crops impossible to cultivate, but even those that normally can mature may be damaged by late frosts in May or June, or by early frosts from July to September. The Clay Belt is far enough north to benefit from the length of the day in summer, but the chief hope of the farmer is in new types of grain and plants which mature early and can withstand frost.

Hills in the memoir cited previously gives the result of his lengthy studies of the soils in the Clay Belt. The dominant types are poorly drained peaty clays; and over much of the area the peat ranges from 6 inches to 4 feet in thickness, and is even deeper in the muskeg areas. Although these peaty clays are dark, rich-looking soils, the organic matter is not only poorly decomposed, woody, and peaty material, but under the existing climatic conditions, strongly resists further decomposition, even upon drainage and cultivation. Most of the peat must be removed by burning. The heavy plastic nature of the underlying clay requires peat or organic

matter in some form to lighten it, so that just enough peat should be left for this purpose. Farmyard manure is especially valuable, since it introduces earthworms and the bacteria which are so necessary for the proper decomposition of the raw organic matter.

As regards crops, Hills is not very optimistic. Owing to the long cold winters and short cool summers the variety of crops grown in these northern podzol areas is not great. Hay, potatoes, roots, and pasture are the main crops. The production of grain is limited by the short season and comparatively low soil fertility. The abundant forage should encourage dairying so as to produce milk and cheese for local consumption. He states that the farms do not produce one-quarter of the products consumed locally which might be grown in the region. In conclusion, he strongly advocates combining forestry with farming, for much of the area can produce better 'harvests' of spruce than of any other crop.

Mr. Hills has very kindly placed at my disposal the results of the last survey of the main Clay Belt, which have not yet been published. It seems well to divide the clay area into an inner elongated area extending from Pagwa to Amos or Senneterre (i.e. the region left blank in Fig. 79), where the farmer finds the clays fairly readily cultivated, and into a much less valuable margin. But in the marginal areas which are about as extensive (and are shown by vertical ruling in Fig. 79), the lacustrine deposits are either too shallow or patchy to be developed on a broad scale for agriculture. In many places in this marginal area the clays are covered with a depth of over 3 feet of peat, which entails too much labour and cost for the pioneer farmer.

Towns and Settlement in the Clay Belt Region

So far only the agricultural prospects of this large region have been considered. But the largest settlements are concerned almost wholly with mining, and derive most of their food and other supplies from distant regions; though it is hoped that this condition will be improved in the near future. Sudbury is the largest town with a population of 42,400 in 1951, which is a remarkable growth from 2,000 in 1901. It is on the southern edge of the great 'Nickel Syncline' from which most of the nickel of the world is derived (Fig. 139). Copper Cliff nearby, where much of the smelting of the Sudbury field is done, has about 3,700 inhabitants. Timmins is the second largest town, and has grown from a population of 3,843 in 1921 to 27,743 in 1951. This is due to the spectacular success of the Hollinger and neighbouring goldmines. Some description of them will be found in the chapter on Mining (p. 436). North Bay is near the southern boundary of our region on the shores of Lake Nipissing. Here is a mixed farming and lumber population,

with some mining and large railway shops. Its population is 15,600. Pembroke, Orillia, and Barrie are also on the southern edge of the Shield, and so on the borders of this region and 'south Ontario'. They have about 10,000 inhabitants in each case. Cobalt, about 100 miles to the east of Sudbury, has seen its best days, for it had 5,600 citizens in 1911, but dropped to 2,376 by 1941. In the Clay Belt the farming population is naturally much scattered. Kapuskasing is the largest town, and due almost wholly to the paper-mill, has a population of 4,687 folk. New Liskeard, more definitely a farmer's town, reaches a figure of 4,215. Mattawa on the Ottawa River has a population of 3,097.

A Traverse of the Clay Belt and Adjacent Shield

In 1936 I made a journey through the Clay Belt from Cochrane westward to Redditt, which is near Kenora and just within the Ontario border. This is a distance of about 600 miles, of which the eastern half is in the Clay Belt, while the western portion is beyond the main Clay Belt. There are about a hundred railway stations in this distance, but only a few are of any importance as settlements. The following table shows the diverse character of these places:

Small towns	Fishing centres	Airports	Little farming	Sidings where trains pass
Redditt Sioux Falls (2,364) Armstrong Nakina (200) Hearst (600) Kapuskasing (4,687) Cochrane (4,301)	Farlane Canyon Savant Mud River Johnstone (each 6 houses)	About 10, under construction, in 1936	Quibell Amesdale Taggart Pelican, and 8 at east end	Most of the remaining stations have only 2 or 3 houses for maintenance men
Total, 7	Total, 5	Total, 10	Total, 12	Total, 70

All the country from Redditt eastward as far as Nakina was much the same. The Shield was well covered by small trees, mostly spruce, with not much bare rock visible, indeed probably less than 10 per cent. Sioux Lookout (Fig. 55) is quite a large town, where the Canadian National Railway has a link to Fort William. It is the centre of an important lumber and mining area, with a large hospital and private and Government airports. Here we picked up many Cree Indian children who were travelling east from school to join the tribes on the Pagwa River near Nakina. On the whole, the spruce improved as we journeyed east, especially near Paska some 30 miles from Nakina.

Nakina is the typical little Shield town, with some 50 houses,

three stores, and an hotel. It is also a Railway Division station, where engines are changed and coal, water, &c., taken aboard. It was during my visit in the midst of forest fires, and a day or two earlier the settlers had feared they must abandon the town and leave for the west by a train waiting for that purpose. Here trains were changed, since the section to Hearst only operates infrequently, and the main train runs south to Longlac to join the main line from Nipigon to Sudbury. There was hardly a settler for 140 miles as we moved eastwards, though Indians and trappers hunt fur in these forests. Near the Pagwa River the country had a somewhat lower elevation (600 feet) and here we entered the true Clay Belt. But the Government is wisely forbidding sporadic settlement, so that

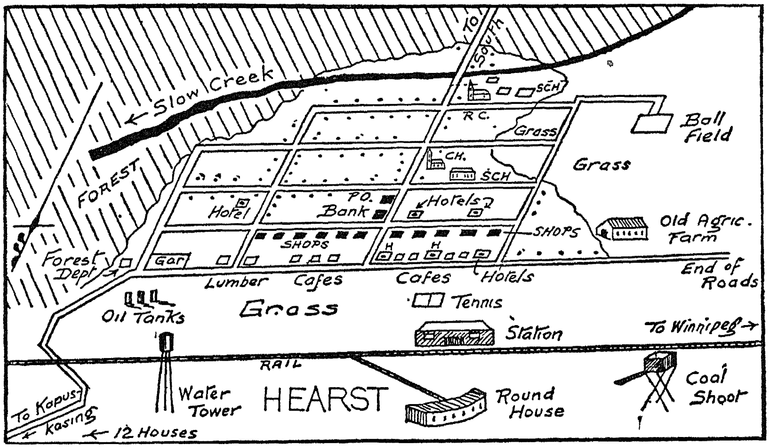


FIG. 80.—A bird's-eye view of Hearst (in 1936), a town of about 600 people at the western end of the Clay Belt. (Small houses are shown by dots, and the street grid is rectangular)

there are few farms west of Hearst at present. The railway cuttings showed pale ochre loam, crowned with poplar and spruce some 12 or 15 inches in diameter. The sole crop consists of blueberries (*Vaccinium*), which are sent to Winnipeg by the Indians.

A diagram of Hearst as it appeared in 1936 is given in Fig. 80. This little town was until 1943 the end of the roads in northern Ontario, and was also the chief centre of the western Clay Belt. A good deal of lumber is obtained, and several paper-mills have been erected to the east. Hence it was the end of civilization in a sense, and the fact that it was a railway 'Division' station also increased its importance. Indians from the north made it their supply town; and the Catholics had a 'separate' school, as well as the church and convent. The diagram shows the arrangement of

the railway sheds. The main road to Kapuskasing runs alongside the railway, and a bus linked Hearst to the latter town most weekdays, though the train ran only twice a week. The shifting character of many of the people accounted for the large number of hotels and cafés; while the small shops were congregated in the second street from the railway. There was for a time an agricultural research station at Hearst, whose barn appears in the diagram. The 'Ball Field' for baseball was close to the sluggish creek, which ultimately enters the Missinaibi and Moose Rivers, and so reaches Hudson Bay. (The road to Nipigon was opened in 1944.)

A few notes on the remainder of the journey to Cochrane will indicate the environment in the more settled parts of the Clay Belt. Much of the land near the railway has been cleared, since here the farms are almost continuous to Cochrane and thence south to southern Ontario. Hallebourg, Val Coté, and Fryatt have each about a dozen houses and one or two stores. The settlements are surrounded by large meadows where hay is harvested. Most of the settlers are French, who have expanded along this railway from Quebec. Mattice is somewhat larger; with a school, church, and a Hudson's Bay store. Opasatika (*pron.* Ôhpah-sàti-ka) is much the same, with a very prominent fire-observation tower to identify forest fires. There are a number of Mennonites here, and it contains four stores and a sawmill. Harty and Valrita are much smaller, though the latter also has a sawmill.

One great trouble in the Clay Belt is the temporary character of some of the holdings. The settler can get $5 a cord for pulp logs, and he may obtain 1,600 cords from his 160-acre block. As my informant put it, 'He first clears off the spruce, and then clears off himself'—to repeat the process on another block. Kapuskasing (*pron.* Kàpus-kāsing) is almost wholly supported by the huge paper-mill, which gets its electric power from Smoky Falls some 50 miles away (see photo 3 on Plate II). There were about 900 workmen in the mill, and about 600 employed in the bush collecting pulp logs. The little town is well laid out, with a large brick hotel, and stores, theatre, &c., maintained by the Paper Company (Fig. 79).

Continuing the traverse to the east, we pass through Moonbeam which possesses a church, sawmill, six shops and an hotel. Much of the spruce has been cleared from this part, and it is stated that it may take 100 years for it to regenerate; though unfortunately not much care is taken to ensure a new crop in many places. Fauquier is a little town of about the same size as Moonbeam. At Smooth Rock is another paper-mill, with the usual huge pile of pulp logs some 50 feet high awaiting conversion to paper. Ground Hog River was crossed by a free ferry run by the Government. For some 10 miles the road passed through fine untouched spruce forest, which

is reserved for future use by the local paper-mills. Cochrane is a little lake town of about 3,000 folk.

NATURAL REGION 12: PEACE RIVER AREA [1]

This natural region has no very well-marked features separating it from those adjacent to it. It is emphatically a transition area as far as settlement is concerned; for it was almost empty before

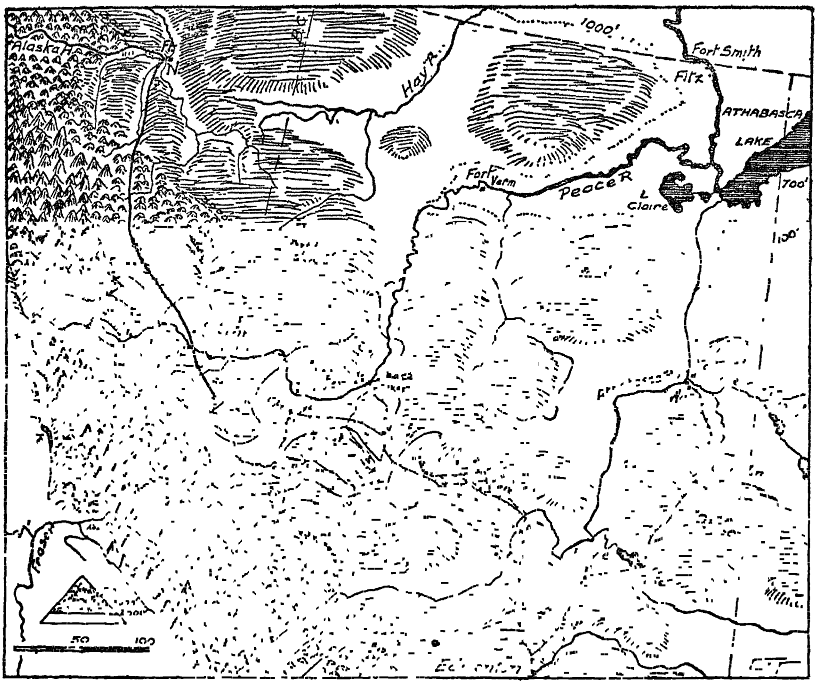


FIG. 81.—A simplified block diagram of the Peace River Region, including also the country between Edmonton and Fort Smith. Dotted areas include most of the far northern farmlands. The Alaska Highway is indicated

1910, and now has thousands of settlers and includes many small towns. Indeed it is on the whole more prosperous than the Clay Belt, in spite of the absence of metal mines and of large pulp-mills. This is due to the climate, which on the whole is better suited for agriculture than is that of the northern parts of Ontario or Quebec. The map in Fig. 81 shows by the dotted areas where the chief settlements on the Peace River have taken place. But the conditions in summer do not alter materially throughout the large triangular

[1] See H. M. Leppard, 'Peace River Settlement', *Geog. Review*, New York, January 1935, with useful distribution maps.

region lying between Edmonton, Lake Athabasca, and Fort Norman. Hence we may confidently expect the type of farming which has developed in the upper Peace River valley to spread down the river somewhat, and to include much of the upper Hay River as time goes on. It is largely a question of the suitability of the soil, for the topography and climate are fairly uniform throughout.

The build of the region, except close to the Rockies, is very simple; for it consists of almost level-bedded Cretaceous rocks. Along the Peace River in the foothills of the Rockies the Lower Cretaceous rocks are at times 5,000 feet thick. The coal near Hudson's Hope belongs to this formation. The topography consists of rolling country, at about 2,000 feet elevation in the west and somewhat lower in the east. The main rivers have cut down rather deeply into this undulating surface. Thus the Peace River from Hudson's Hope to Peace River town flows at the bottom of a valley some 500 feet below the general level. This river is nearly a mile wide near Vermilion Chutes. The lowest portion of the Peace River where it joins the Slave River is very swampy; and the whole area around Lake Claire has somewhat of the character of a delta, with the distributaries flowing in various directions according to the state of the floods in the various upper rivers. At Fort St. John, where the new bridge has been placed for the Alaska Highway, there are rich fertile flats along the river several hundred feet below the general level of the country, which early attracted farmers; but such low-level flats are by no means general along the big river.

As regards climate, the Peace River basin has the usual conditions of the interior of a cool continent. The range of temperature is considerable, amounting to 70 or 80 degrees Fahrenheit. The summer is hot and the winter very cold, as the following table suggests. The rainfall is almost wholly a summer one, and the total varies from 12 to 15 inches. The sole area which is a close homoclime is found in south-west Siberia in the basins of the Irtish or Upper Obi Rivers.

COMPARISON OF PEACE RIVER AND WEST SIBERIA

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec	Total
Beaverlodge, T.	1	7	22	37	47	55	57	56	48	37	20	10	33° F.
Rain	1·5	1	1	0 5	1·7	1·7	2	1·7	1	1	1	1	15 in.
Peace River, T.	−9	3	20	36	50	56	60	57	48	38	17	5	32° F.
Rain	1	0·4	0·5	0 3	1·4	2·5	2	2	1	0·5	0·5	0·6	12 in.
Barnaul, Temp.	−2	1	13	33	51	62	67	62	50	35	16	4	33° F.
Rain	0·3	0·2	0·3	0·4	1	1	2	2	1	1	1	0·6	10 in.
Beresov, Temp.	−11	−2	11	21	35	51	61	56	42	25	4	−7	24° F.
Rain	1	0·6	1	1	1·6	2	3	2	2	1	1	0·5	18 in.

It is worth noting that in Siberia these two towns are well within

the settled regions. Philip's chart of population shows Barnaul as within the large area in central Siberia with a density of over 16 per square mile. Tomsk, Omsk, and Toboslk lie between the two places whose climatic data appear above (see map, p. 512), but they are favoured by rather better rainfall than that of Peace River.

Kitto describes the climate as follows:[1]

The winters are by no means mild, but are very dry, with clear skies, little snowfall and few winds. Blizzards are unknown, but mild Chinook winds give balmy days to break the monotony of a steady cold. Spring comes early and quickly and the snow soon disappears, and the ground is dry in a few days. Ice on the lakes and rivers breaks up during the latter part of April or early in May.

Halliday describes the soils as derived from morainic and till deposits. They are of podzolic type, and usually contain much lime derived from the Paleozoic rocks to the north-east. The forests consist of a mixed series of aspen, balm of Gilead, white spruce, white birch, and balsam fir. The two poplar types occur chiefly on the heavier soils. Jack pine predominates on the sandy soils, while this tree with black spruce is found on the flat-topped hills.

As Dawson points out, the Peace River settlements fall into separate groups with considerable distances between (Fig. 81). To the west of Peace River town there are two separate districts of Fairview and Berwyn which consist of open plain or parkland. North of Berwyn is a belt of wooded land covering a poorer soil, with here and there muskeg. Far to the north, some 50 miles away, is the Battle River prairie. At a considerable distance to the west is Hines Creek. All of these lie north of the Peace River itself. To the south a continuous series of settlements extends from Grande Prairie to Rolla. The Grande Prairie section is bounded on the west by a 50-mile belt of rough land, wooded for the most part and interspersed with muskegs. The prevailing soils are dark brown or black clay loams, but there are many patches of light sandy or leached timber soils. In the region as a whole the land is very uneven in fertility (*Settlement of Peace River Country*, 1934).

Early Settlement in the Peace River Area

As the result in part of the famous journeys of Mackenzie, the North-West Company founded trading posts at Fort Fork (near what is now Peace River town) in 1792, at Dunvegan in 1800, and at Fort St. John in 1805 (Fig. 81). During the early years of the century, there was no agriculture except for a few acres near the posts. The first farming of note started at Shaftesbury near the

[1] *Peace River District*, Ottawa, 1922.

town of Peace River in 1880, where Catholic and Anglican Missions were established. Grouard, at the west end of Lesser Slave Lake, was the chief land office in these early days.

By 1890 the railway reached Edmonton, but it was a considerable distance north of this town before the fertile lands of the Peace River area could be reached. The first large influx of homesteaders began in 1910, and they usually drove teams from Edmonton or Edson, on the railway farther to the west (Fig. 81). By 1911 there were over 1,100 settlers in the region, in addition to about the same number of native Indians. Beaverlodge (near Grande Prairie) was an early settlement, for a group of Methodists arrived there in 1909.[1] Railways soon entered the area, for Peace River town was reached in 1916, and Hines Creek to the west of this centre in 1930. Grande Prairie to the south was linked in 1916, and Dawson Creek in 1930.

The high prices paid for wheat during the last war helped to boom this pioneer region. The first carload of wheat was hauled out of Vanrena in 1914, and transported 100 miles to the railway. In the Rolla district early settlers hauled their wheat and hogs for 60 miles to the nearest railway at Spirit River, though now the railway is only 8 miles distant.

Dawson and Murchie give the following picture of the year's work. Break-up of the ground is done from 15th March to 10th April, and seeding till the end of May; while summer fallow is ploughed in during mid-June. Haying extends from the middle of July till August 1st for tame hay, and somewhat later for the wild hay. Harvest begins about 15th August and lasts for about a month, followed by threshing which lasts till the middle of October. Clearing the bush follows, and the first snow comes about 15th November. During the winter the wheat is hauled to the railway.

Demobilization led to many more settlers until about 1920, when a period of low prices produced a depression in Peace River as elsewhere. This was followed by a wave of prosperity from 1926 to 1931. Good roads were built through the region as far as Fort St. John during the years of depression, and this helped the farmers to get their crops to railhead much more cheaply. A better knowledge of the special agricultural problems of this northern region now became general. Researchers like Albright and Trelle contributed greatly to the advance of agriculture in this part of the Dominion.

In 1921 there were 3,578 farms in the region, occupying about 880,000 acres. Wheat to the extent of 58,000 acres, and oats amounting to 85,000 acres were cultivated. In this year 23,000 tons of wheat and about 19,000 tons of oats were shipped out by rail.

[1] An excellent study of pioneer settlement is to be found in the book by Dawson and Murchie on this region, published in Toronto, 1934.

In 1946 there were 5,754 farms, and the grain exported amounted to 334,000 tons of wheat and 70,000 tons of oats.

The total populations of the two areas in the Peace River region (i.e. in Alberta and in British Columbia) are given in the following table. (There has been not much change by 1951.)

	Alberta	British Columbia	Total
1911	1,165	—	1,165
1921	12,131	1,694	13,825
1931	29,278	6,685	35,963
1941	47,833	8,481	56,314

There is a considerable mixture of cultural stocks in this newly settled region. In 1931 50 per cent were of British ancestry, 12 per cent were Scandinavian, 30 per cent came from the rest of Europe, and about 7 per cent were native Indians. Norwegians have settled near Valhalla, while Germans form a Catholic community at Friedensthal near Fairview. French Canadians have settled near Grande Prairie and McLennan, and Russians have taken up land in the north near Battle River and Clear Hills.

The most important crop is wheat; which, with 80 acres per farm, forms about 45 per cent of the improved acreage. Oats constitutes about 21 per cent. The average farm-size depends on the position of the farm. Murchie divides the region into three zones: i.e. early settlements along the railways; farms near the highways; and remote farms. In the oldest zone the farms run to about 475 acres each. In zone 2 they average 518 acres, and in the pioneer zone 275 acres. The character of the crops varies in these zones, since in the outer pioneer zone the farmer must produce feed for his stock rather than wheat for sale. Thus 49 per cent of the land in the older farms produces wheat, while only 13 per cent of the improved acreage in the fringe is used for the pay crop. In the northern districts oats is grown more generally than wheat, since it can stand frost better and needs a shorter growing season. Another characteristic of the pioneer zone is the greater importance of cattle, since they can be transported to the railway more readily than grain.

Water-supply is a big problem, especially for the pioneer farmer. If there are streams they can be dammed, if not then the pioneer has to rely on 'dug-outs' cut in clay soil, in which he can collect surface water or winter snow. Wells which flow are unknown, except in the Hythe district. In many parts it is necessary to dig or bore for several hundred feet to reach water-bearing strata, and this is beyond the powers of the pioneer.

A very interesting table by Dawson and Murchie gives a compre-

hensive idea of the social amenities of life in the Peace River area in 1934. The *distances from various facilities* are listed for 194 households in the early-settled areas, and for 67 in the fringe.

Type of service	Early-settled	Fringe area
1. Grade school	2·3 miles	12·2 miles
2. Post office	4·0 "	9·1 "
3. Community hall	4·3 "	12·3 "
4. Church	5·0 "	15·4 "
5. Doctor	10·5 "	22·9 "
6. Bank	8·1 "	35·9 "
7. Hospital	15·6 "	57·1 "
8. Shipping Point	7·8 "	49·8 "

A Traverse of the Peace River Region in 1944

In August 1944 I made a survey of conditions in the north of the region near Fort St. John, and also studied the character of the town which had developed at railhead at Dawson Creek.[1] On the journey of 230 miles from Dawson Creek to McLennan (Fig. 81) I noted the general features of the numerous small settlements; and a résumé of my notes may well complete this brief account of Peace River. (The Alaska Highway is described on pp. 281–283.)

As one journeys south along the Alaska Highway from Fort Nelson, there is practically no sign of agriculture until the St. John district about 54 miles north of Dawson Creek is reached. Here wide clearings in the uniform forest meet the eye, and we are reaching the northern extension of farmlands in this part of the Dominion. In the next 10 miles a number of farms are passed, as well as some abandoned shacks. Fort St. John with its hotels and cinema is quite unlike most of the towns to the north, except Whitehorse and Dawson City in the Yukon.

In 1928 most of the new settlers were living in tents, and the first log hotel was just being built. The present Hudson's Bay store was moved here in 1925, though there had been a post on the river nearby as far back as 1805. The Anglican Church was built in 1930, and the hospital and flour-mill about 1933. As a result of the building of the Alaska Highway past the corner of the town, there has been a great increase in the population. The street plan is the conventional grid. There are half a dozen shops in the main street, three hotels, and two fur-buyers. The three churches, the hospital, the school, and such activities as the Rink, Auto-camps, &c.,

[1] 'Yukon Domesday, 1944', *Canad. Jnl. Economics*, Toronto, July 1945, includes a description of the country traversed on this survey as far south as Dawson Creek.

are in marginal positions. In 1941 there were 170 residents in Fort St. John, but the number has increased considerably in the last three years partly owing to the large airport.

The owner of the local 'Illustration Farm' kindly supplied me with data as to the crops hereabouts. He grows mostly spring wheat, which is sown about the third week in April. The harvest takes place about the end of August, the time depending largely on the warmth in the soil at the time of seeding. Potatoes are planted in the middle of May, and some early potatoes may be dug early in August. Oats, alfalfa, and flax are other crops which do well; while hogs are an important product in parts of the district.

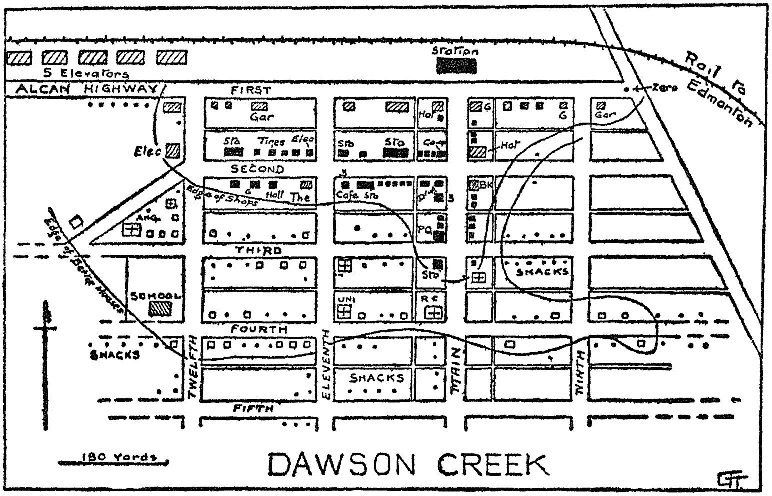


FIG. 81A.—Plan of Dawson Creek at the southern end of the Alaska Highway

There is not much farming on the road from St. John to Dawson Creek, though Rolla to the east is a progressive district (R. in Fig. 81). At Dawson Creek the Alaska Highway reaches railhead and terminates. This little town has been exceedingly busy during the building of the Highway as may be imagined. Whole blocks of barracks surround the original town, erected for the use of the hundreds of Americans who were imported to aid in building the road. Five tall wheat elevators, on the last half-mile of the Highway, show that we are well into civilization.

The plan of this interesting town appears in Fig. 81A, but the American barracks are omitted, since it was not permissible to survey them. The grid is modified by the presence of narrow lanes through the centre (or thereabouts) of the town blocks. The railway runs west–east, and First Street (which is the end of the Alaska or Alcan

Highway) parallels the railway on the south. Here are the chief warehouses and some garages. Main Street runs north–south from the station, and contains the two chief hotels and the Post Office. Along Second Street are most of the stores, the theatre and Recreation Hall. Thus the business section forms in plan a sort of 'T', including First, Second, and Main Streets, and this is a very general pattern in these 'grid towns'. A zone of better houses surrounds the business sections, in which are found the five churches and the large school. Outside this zone, chiefly to the south of the town, are streets with many poor houses and shacks. Thus in the early days of a small town the better houses are near the business sections, though this arrangement tends to be modified as the town changes to a city. As in the case of St. John and other farming towns, there are many shops compared with the number of residents actually living in the town, for their customers come from the numerous farms in the widespread district.

Pouce Coupe, 6 miles south of Dawson Creek, is surrounded by cleared land in all directions. It has two grain elevators, several churches and shops, and about 200 houses. After passing several tiny settlements we reach Demmit in Alberta, where there has been an influx of Sudeten Czechs since 1935. Hythe is a much larger place, of about the same size as Dawson Creek. The country to the south is still largely in its original poplar forest, though with occasional clearings. At Albright is a lonely elevator, and only one or two farms near the tiny station. Beaverlodge is the site of the experimental farm, where such fine work has been done by W. D. Albright. It has six elevators, which is an index of its importance. Huallen, Wembley, and Dimsdale have each three or four elevators. Grande Prairie is the main town of the settlements in the south of the Peace River area (Fig. 81).

Grande Prairie has progressed steadily in the last thirty years, having a population of 1,061 in 1921 and of 2,661 in 1951. According to Dawson (*op. cit.*): 'It is the headquarters for banks, insurance companies and agricultural representatives, and has the finest hospital and high school in the north country'. About a dozen miles to the north is Sexsmith with seven elevators and a dozen or more stores. It is near the margin of the Grande Prairie agricultural district, and the railway now passes through poplar forest for many miles with only a few clearings. At Rycroft and Spirit River, however, the land is largely cleared.

Some notes on the plan of Rycroft will illustrate this part of the Peace River Region. The little town is completely surrounded by grain fields, and six streets, i.e., the Main Street, flanked by one on each side, and crossed by three others, sum up the whole pattern of the grid. The Main Street runs at right-angles to the railway,

and contains six small stores, an hotel, and a bank. A fairly large school has been built at the further end of this street, while a Rink and Assembly Hall are across the railway. About fifty wooden houses, mostly of one storey, complete the picture. Alongside the station are three grain elevators and the usual high coal-shoot.

To the east of Rycroft there were six small stations serving scattered clearings, of which Belloy and Eaglesham each exhibited one grain elevator. Near Watino are fine river flats all along the banks of the Smoky River, though the little town of Watino only contains a few shops and a dozen houses. After crossing the river and climbing up the other side of the valley, we pass through a district with many settlers of French origin. Girouxville, Dreau, and Falher are little towns in this group ; and the latter is notable for the huge church with two flanking towers and for the large school adjacent. Here also are enough farmers to support five elevators. McLennan has also a considerable Catholic population, as is indicated by the large building crowned by a life-size statue of a saint (Fig. 81).

In concluding these notes on the Peace River it is permissible to look to the future for a moment. Some writers claim that there are 47 million acres of cultivable land in this region ; and the optimists expect 3 million settlers there in a generation or two. This is probably wishful thinking ; but the best approach would be to study how progress has occurred in quite similar but earlier settled lands in Western Siberia, and use such data to aid us in our forecasts for the Peace River. The writer believes that progress will be continuous but slow. There is no return without hard work and applied knowledge. It is no region for the ignorant and impecunious emigrant; though if such be endowed with brains and brawn he can serve an apprenticeship, and then settle with good prospects of success in the extensive remaining second-class lands of the Peace River. (The region along the lower Athabasca River is described on page 259 in the section dealing with the Mackenzie Region.)

Note on Newfoundland Fisheries

The fisheries rank second in the exports of the island, and in 1943–4 they were worth 18 million dollars ; whereas paper-pulp was valued at 42 million dollars. Codfish produced 82 per cent of this export total, and they are caught mainly in the ' inshore fishery ', based on the innumerable fishing villages scattered all round the coasts. Deep-sea fishing is also carried on by schooners, which frequent the Banks (p. 342). The herring fishing takes place largely in the bays, especially near Cornerbrook. Salmon are taken in the summer off the east coast, while lobsters are numerous in the shallow waters of the south and west coasts (Fig. 107).

CHAPTER X

EASTERN PIONEER LANDS

NATURAL REGION 13: LABRADOR

THIS very large area of 110,000 square miles is now a portion of the Dominion. As the result of the award of 1927 it was handed over to Newfoundland, so that it became part of the tenth province in April 1949. But in many ways the settled portion of this large territory differs greatly from the adjacent region of north Quebec (Region 14). The tundra environment extends down the whole coast as far as Hamilton Inlet; and the vast valley, extending eastwards from the famous Hamilton Falls and including Lake Melville, is somewhat distinct from the rest of the interior, since Halliday in his valuable study of the vegetation makes a separate class for the forests in this part of Labrador. The population of this vast 'annex' to Newfoundland was, however, only 4,716 in 1935.

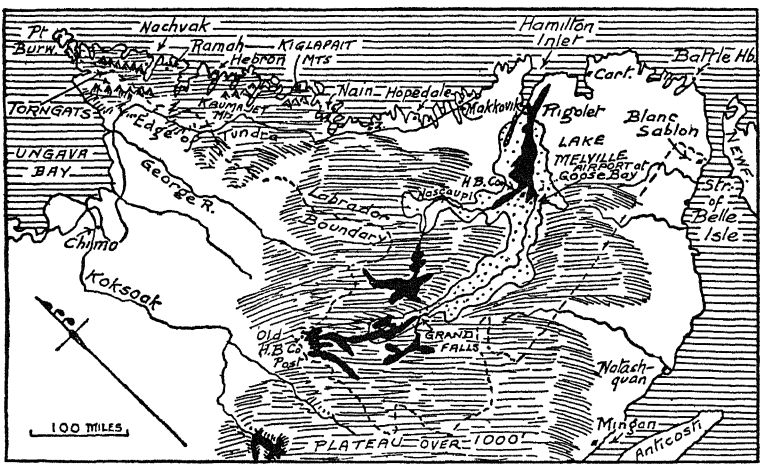


FIG. 82.—A sketch map, of Labrador, showing the cirque-carved Torngat mountains in the north, and the Hamilton valley (dotted), with its better forests and airport, in the south. The plateau over 1,000 feet is indicated.

The whole region forms part of the Canadian Shield, but there is a coastal range of mountains north of Hamilton Inlet, which rises towards the north to heights well over 5,000 feet in some of the Torngats (Fig. 82). Daly is of the opinion that this range indicates

the existence of a former north-west to south-east mountain trend, which is at right-angles to the well-known Appalachian trend. (The latter is indicated by the ridges and depressions already described as characterizing Newfoundland's build.) In places, especially for 50 miles north of Ford Harbour, there are enormous masses of intrusive gabbro, including fine specimens of the felspar Labradorite—which indeed was named from this locality. All the rocks have been fissured in many localities, and the fissures filled with basalt dykes and sills, which Daly dates as Pre-Cambrian in age. Vertical dykes are abundant in Mt. Blowmedown near Nain, while Striped Island gets its name from the numerous horizontal sills of the same basalt.

The whole Labrador region has been uplifted in the latest period of mountain-building, and nowhere in the world is there a finer example of a cirque-dissected tableland than in the north-east corner of Labrador (Fig. 83). Near Nachvak the mountains are truly alpine in form, their summits perhaps rising over 5,000 feet. To quote Daly,[1] ' It is not too much to say that the Torngats afford the most lofty land immediately adjacent to the coast in all the long stretch from Baffin Land to Cape Horn.'

The latest discussion of the topography of Labrador appears in one of the valuable monographs published by the American Geographical Society in 1938. In this volume, *Northernmost Labrador*, N. E. Odell describes the landscape somewhat as follows. The Labrador Plateau is undulating and traversed by ridges of low rounded hills that seldom rise more than 500 feet above the general surrounding level. Many rivers make their way outwards by irregular channels from the low and almost indefinable ' height of land ', or watershed. The north-east coast, however, is dominated, as stated, by mountain ranges, which fall into three groups. In the south are the Kiglapaits (i.e. ' Sawtooth ' in Eskimo) which are near Nain ; in the middle the Kaumajets (' Shining-tops ') are some 60 miles north near Cape Mugford ; and in the north the Torngats (' Devil Mounts ') which cover much of the northern 130 miles of the coastlands (Fig. 82).

Odell gives us a very interesting description of the Torngats, which seem to consist of two parallel series of peaks, the coastal series and the interior series (Fig. 82). The coastal range contains more rounded summits in the south, but is more deeply dissected in the north, where it displays a complicated network of sharp peaks and ridges. ' Nothing is more striking than the beautifully carved cirques, chiselled into the mountain sides.' These cut back and approach each other forming typical *aretes* or crests such as are common in the Swiss Alps and elsewhere (Fig. 83). Many residuals

[1] *Labrador*, New York, 1909, by Grenfell, Daly, Low, and others.

of the former peneplain surface are to be seen, such as Castle Mountain and many flat-topped summits near Nachvak Fiord. Mt. Razorback rises as a serrate crest 3,500 feet above Nachvak, the finest fiord along the Labrador coast. This fine mountain is composed of a rather rare pyroxene gneiss known as 'Charnockite', which curiously enough is rather common on the coasts of Antarctica to the south of Australia.

The southern Torngats are made up of two Pre-Cambrian formations. Near the coast are the resistant gneisses and granitic rocks

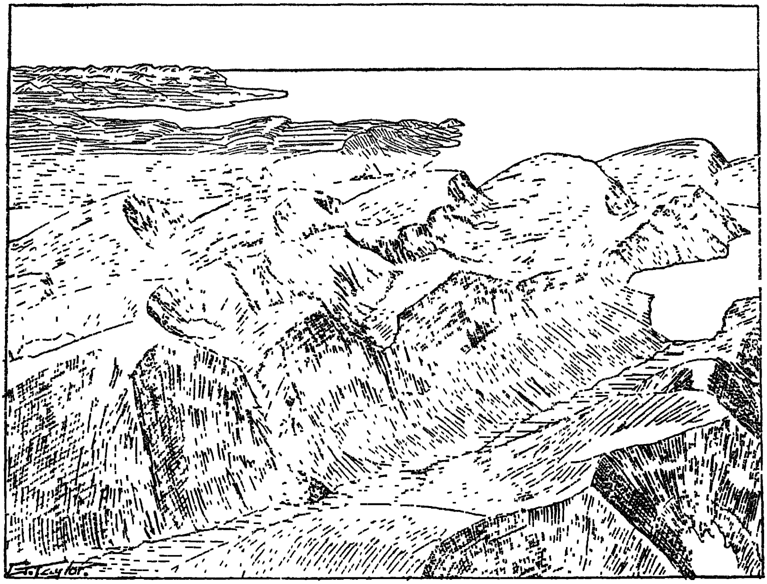


FIG. 83.—Sketch of the cirque topography in the coastal Torngats, Labrador. Looking north from Mt. Razorback (Nachvak Fiord) to Seven Isles Bay. (From a photo by A. Forbes)

of Mt. Blowmedown, but inland is an imperfect syncline of the softer series of slates and dolomites known as the 'Ramah series'. These give rise to a lower, much more even, and rounded landscape. West of Mt. Tetragona (near Nachvak Fiord) is a central trough 5 to 10 miles wide, and to the west of this again is the Interior Range. It is built up of garnet-bearing granulites, and a few peaks rise to 5,000 feet. (See V. Tanner in *Geog. Jnl.*, p. 242, May 1946.)

The Kaumajet Mountains are composed of lavas and ashes laid down on the older granite surface (Fig. 82). One of the highest peaks is the Bishop's Mitre, whose upper part is formed of trachytic tuff, while the 'cleft' is due to the weathering of a volcanic dyke.

The Kiglapaits are characterized by the abundance of labradorite, and the rock anorthosite in which it occurs is probably of late Archean age. The lustrous mineral has been quarried near Nain, but not with much success financially.

Odell discusses the character of the last great phase of the topography, that due to the Ice Ages. He is of the opinion that ice covered all of Labrador, and may have submerged many of the cirques, which are so abundant in the Torngats. This is quite in line with the present writer's experience in the Antarctic in 1910–12, when he saw and described many examples of cirques flooded with the ice-cap, and at times even submerged beneath the sea (*vide Physiography of Macmurdo Sound*, London, 1922).

E. C. Abbe in the same publication (1938) discusses the survival of pre-glacial plants in various parts of North America. Such plants as various species of sedges, chickweed, ragwort, fireweed, and sandwort, are found only in a few localities in the north-east part of the continent and in the western cordillera. Abbe, however, discovered that the highest parts of the Labrador mountains contain lichens and mosses, and not species of the type mentioned above. *Poa, Luzula* and *Cardamine* are flowering plants which occur at lower levels, and at times reach to the summits; and no special group of alpine species is found here at all. The possibility of post-glacial migrations is raised by Abbe to account for such isolated relics as are found on the Gaspé Mountains, &c.

Climate and Vegetation of Labrador

We owe to C. E. Koeppe[1] a fairly full account of the climates of Labrador. He points out that the cold Labrador current causes the coasts to be bleak and barren. As shown on Fig. 40 the vegetation here is of the tundra type, and the local folk must depend on driftwood for their fuel. Near the heads of the fiords, however, forests appear; and the trees are larger as one moves west from the cold ocean waters. Inland most of the cold climate vegetables can be grown with some care, but this is hardly possible right on the coast.

At Hebron August is the warmest month with a mean of 48° F. and January is the coldest with a mean of − 6° F. Thus though the summer is cool the winter, though it is cold for its latitude, is not particularly cold compared with places in the interior of the Dominion. Winter begins in October, and continues into May. Summer does not exist, though a few days may record temperatures as high as 80° F. or more. Precipitation varies around 22 inches, and the wettest months occur in the autumn. January, February, and March are the sunniest months. The following table gives the main data for the village of Hebron on the north coast (lat. 58° 12′):

[1] *Climate of Canada*, Bloomington, 1931.

	Jan	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Hebron, T.	−6	−5	6	18	31	40	47	48	41	31	20	4	23° F.
„ Rain	1	0·7	0·8	1	1·5	2	2·7	2·7	3·3	1·6	1	0·6	19 in

Probably its nearest homoclime is with Hakodate (north Japan) or southern Sakhalin, but the coldness of the summer, due to the Labrador current, prevents any close approximation.

The forests of the interior of Labrador have already been described, since they are the same as those covering the greater part of northern Quebec (p. 104). Essentially, the trees consist of stunted black spruce and balsam fir, while treeless moors are common in the higher ground. But in the extensive Hamilton valley there is much more protection for the trees, and the soils are more fertile (shown dotted in Fig. 82). This valley is often about 800 feet lower than the general plateau, and it supports a forest containing trees of commercial size. Among these trees are white and black spruce, balsam fir, white birch, aspen, and balsam poplar. The middle portion of the Koksoak River is similarly protected, and has a forest of the same kind, though white spruce and balsam poplar are absent here.

The response of the settlers and natives to the rather powerful control exercised by the climate is summarized in the following table, which is based on data given by Grenfell in various writings:

CLIMATIC CONTROL IN LABRADOR

Month	Climate		Hunting	Fishing	Navigation
Jan.	−6°		First dog teams	Harp seals	Belle Isle frozen
Feb.	−5°		Trap sables		
March	6°	Bright	Good sledging and best fur	Annual seal hunt	
April	18°	Thaw	Fur poor	Trout fishing	Mail steamer from Newfoundland
May	31°	River ice breaks up	Bears leave caves		South water free
June	40°	Snow gone	Deer to hills	Cod in south	Fishing ships in
July	47°	Mosquitoes		Cod in Fiords	Steamer to Nain
Aug.	48°	*do.*		Cod in north	Yachts reach north
Sep.	41°	Snow in north	Caribou in lowlands	Cod in deep sea	
Oct.	31°	Night frosts	Begin trapping	Fishing ends	Yachts leave
Nov.	20°	Winter	Trap fox	Net seals	
Dec.	4°	Dismal	Good fur	*do.*	

The Labrador Environment

Only along the Hamilton River is there anything in the way of settlement in the interior of Labrador. A good description of the

environment in this part of the region has been given by A. P. Low (*Labrador*, 1909), in which he tells us of the appearance and resources of this district before the war and the development of flying altered things very materially. Hamilton Inlet is 150 miles long, and about 14 miles wide. It is a deep fiord surrounded by hills often rising 1,000 feet sheer from the water. Forty-five miles above the entrance the inlet narrows, and is only about a mile wide for upwards of 5 miles. During each change of tide a strong current with rapids occurs at this point.

Rigolet, an old post of the Hudson's Bay Company, is situated on the north side of these narrows, and the most southern settlement of the Eskimos was to be found here some forty years ago (Fig. 82). The voyager now enters Lake Melville, which is 15 miles across at the widest. About 80 miles inland North-West River enters, and originally the chief post of the company was at this point. As early as 1800 there was a farm there, where oats and vegetables were readily grown. Close to this post is Goose Bay, where today is one of the largest airports in the world. (It is described later.) For many years there has been a timber-cutting settlement in this district, where the loggers have built their huts. They grow potatoes, and also take part in the cod fishing on the coast. But Low gives a rather gloomy picture of their method of life.

Some 200 miles to the west of Lake Melville are the Grand Falls on the Hamilton River. Below the falls there is the deep Bowdoin Canyon, cut below the level of the plateau as much as 1,000 feet in places. This deep valley varies in width from 100 yards to more than 2 miles between the rocky walls. There is now a portage of some 20 miles, which Low advises those who wish to see the falls to advantage to traverse. At the top of the falls the level is 1,660 feet above the sea, whereas where the river issues from the Bowdoin Canyon it is only 900 feet. Hence there is a drop of 760 feet in less than 12 miles. Low, who was an expert geologist, estimated that the power which could be developed at the main fall of 300 feet, was as much as 1,700,000 horse-power. Bowdoin Canyon zigzags in a manner reminding one of the Victoria Falls in Rhodesia; and in both cases the path of the waters is determined by two sets of joints (vertical cracks) in the rocks over which the river flows. Above the falls the river flows in a mature valley through various large lakes, and heads in Petitsikapau Lake near the 'height of land', and here are Burnt Creek and other mining towns. Here Fort Nauscopee was maintained from 1842 to 1873. Very extensive iron deposits occur nearby (see map, p. 51).

Two well-known travel books give full details of life in the interior of Labrador—*Unknown Labrador* (London, 1908), by Mrs. L. Hubbard, describes a journey in 1905 from Lake Melville up the

Naskopie River and then north by the George River to Ungava Bay. *Through Trackless Labrador* (London, 1911), by H. Prichard, deals with a journey in 1910 for some 150 miles due west from Nain. He writes as follows of the Eskimos in Labrador: 'If ever a policy in the world's history has been proved correct that of the Moravian Brethren in wishing to keep the Eskimo to their old customs has been justified.' These famous missionaries built their first permanent house at Nain in 1771, and have kept their mission going ever since. In 1775 Okkak was established, and in 1782 Hopedale. Since then later missions have been started at Hebron, Zoar, Ramah, and Makkovik.

Formerly many of the Eskimos were to be found on the southern shore of Labrador, but now there are few or none. Makkovik, the first station going north, is chiefly inhabited by half-breeds and settlers (Fig. 82). At the next, Hopedale, the numbers of Eskimos are dwindling. At Nain the death- and birthrate balance each other, while at Killinek, near Cape Chidley, the old methods and the old life held their own, as they do through the ultimate north (Prichard, *loc. cit.*). However, Killinek is now abandoned.

Goose Bay Airport

Two factors among others have recently greatly increased the importance of the interior of Labrador in Canadian affairs. These were the necessity of getting immense numbers of aeroplanes across the Atlantic, and the possibility of German attack on North America by way of Hudson Bay. There developed the 'Arctic Project', to cope with both these problems. The most ambitious plan of all was the establishment of one of the largest airports in the world in the heart of little-known Labrador. A useful book [1] by the Senior Naval Officer, W. G. Carr, has recently been published, which gives many details of interest to geographers with regard to the establishing of the Goose Bay Airport (Fig. 82).

One of the major objections to airports in Newfoundland—the nearest land to Europe in temperate latitudes—is the large amount of fog. In the vicinity of Belle Isle Straits ships may be held fog-bound for five days at a time, but in the interior of Labrador at Lake Melville fog is encountered only on rare occasions (Carr, *loc. cit.*). The actual site was chosen by that intrepid aerial surveyor, Eric Fry, in June 1941; and few stories of the start of a 'city' of 5,000 people are more interesting. After visiting a number of places around Lake Melville, none of which offered the necessary level area for an airport, Fry noted a remarkably level, elevated, terrace on the promontory between Hamilton River and Goose Bay. Here several square miles of sandy terrain were discovered, with water

[1] *Checkmate in the North,* Toronto, 1944.

near by in Terrington Basin where vessels of 21 feet draught could berth.

In September 1941 the engineers arrived to construct the airport, and a long causeway and road was first necessary to link deepwater to the building site. On November 16th, 1941, three runways, each 7,000 feet long, were complete and ready to accommodate the largest planes. Once the project was fairly started, nearly five tons of food a day were required to feed the 3,000 construction men; and four 4,700 ton steamers brought the food for one year from Montreal. Today the airport covers an area nearly as large as Toronto, and 50 miles of roads serve Goose Bay.

In the valleys near the airport there are some good stands of timber, trees of 90 and 100 feet being met with. It may be mentioned that at the North-West Post—about 25 miles north-east of the airport—plenty of vegetables for this small settlement are grown at the Mission. A greenhouse is used to give the plants an early start, and they are put out about July 7th, and grow very rapidly. Carr states that Canada spent $9,950,000 in building the airport, and during one period of 24 hours no less than 150 bombers took off for overseas.

NATURAL REGION 14: NORTHERN QUEBEC

This region, once called Labrador, includes a very large area of the province of Quebec extending between the tree-line in the north, and the Gulf of St. Lawrence in the south. Excluded are the settled regions to the west of Tadoussac, including the Saguenay District, and the fringe of younger rocks along the St. Lawrence, which are part of Region 2. Also the east coast, assigned in 1927 to the administration of Newfoundland, and known officially as the 'Coast of Labrador', has a somewhat different environment and economy, and so has been made into a separate region (No. 13). Our present section is bounded on the west by Hudson and James Bays, and by the north–south boundary of Quebec, south of the latter bay (Fig. 84). The geology is shown in the map on p. 51.

The topography and structure are relatively simple. The region is wholly included in the Canadian Shield, so that its rocks are all exceedingly old, and consist of granites, gneisses and allied rocks. Glacial till covers the whole country, except in those places where the ice seems to have scraped the soils completely off the rocky crust. The centre of the ice-cap was probably in the high ground in the south-east of the area. The surface is a rather undulating peneplain, which goes far back in geological time. Since some areas in the east rise to very considerable heights, i.e. over 5,000 feet in places, it is clear that this peneplain has been uplifted *en masse* relatively

lately, probably during the last period of mountain-building called the 'Alpine Storm'.

In general, the region is a tilted plateau, sloping down to the north or north-west. The largest area of land over 3,000 feet lies immediately to the north of Anticosti Island, near latitude 52° N. But the waters of the north of this elevated region are caught by the Hamilton River, and flow east into the Atlantic, though no other rivers of note take this direction. Thus the Koksoak flows north into Ungava Bay, while the East Main, Fort George, and Whale Rivers flow westward from this high area to James Bay or Hudson Bay.

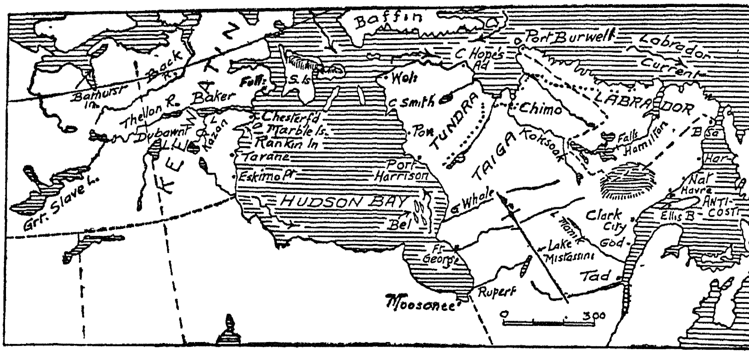


FIG. 84.—Map showing the main features of the Regions of Keewatin and north Quebec

The climate of north Quebec in the centre of the broad peninsula is quite continental as might be expected. The range of temperature is about 70° F. There are no settlements in the vast interior plateau, so that we have no accurate records, but the July temperatures here are around 57° F.; while in January the thermometer falls to − 8° F. or thereabouts. Since the summer temperature is fairly high, it seems likely that in the distant future there may be isolated settlements where there happen to be pockets of fair soil. It should be feasible to grow northern crops such as potatoes, oats, and dairy pasture. But there is no likelihood of this happening until the more attractive portions of the pioneer belt have been occupied.

The chief climatic features may be gathered from the following table, giving data for Fort George (on Hudson Bay), and Mistassini (north of Lake St. John). The rain is fairly uniform but with a summer maximum.

Halliday has divided this vast region into two forest classes, the boundary between the interior and the south coast running about

	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Ft. George, T.	−12	−9	1	22	37	48	54	53	46	35	23	4	25° F.
Mistassini, T.	−2	0	14	33	48	57	64	60	52	40	24	7	33° F.
Rain	2·4	2	1·6	2·2	2·5	3·6	3·7	3	3	2 7	2	2·8	32 in.

150 miles inland of the St. Lawrence. In the southern division the topography consists of a rolling country with a series of roughly parallel and southward-flowing rivers in rather deep valleys. There is a fair amount of alluvial in the floors of these valleys, and the soils are essentially podsols. Balsam fir and black spruce are the dominant trees. White birch, aspen, and balsam poplar are found chiefly in the valleys ; and white spruce, though spread throughout, is not abundant. The pulpwood of the province of Quebec comes from this association.

All the noteworthy population is to be found along the St. Lawrence to the east of Tadoussac (Fig. 82). This littoral has been studied by Blanchard in his book *L'est du Canada Français* (Montreal, 1935) ; from which the following account is taken.

From Saguenay to Blanc Sablon we have only a littoral offered for our study. In the interior are a few hundred Indians who pass a few summer weeks on the coast ; in the north-east are a few white settlers who imitate them in the pursuit of the fur trade ; elsewhere a few whites are engaged in the timber trade. Apart from ' Clarke City ' all the settlements are on the coast.

Geologists have penetrated the interior, much of which is still almost unexplored. All communications are by water along the coasts, for the roads only extend a few miles east of Tadoussac. A telegraph line, however, extends along the whole shore to Blanc Sablon on the borders of Labrador (Newfoundland). From 15th November until the end of April most coastal steamers cease their services, though aeroplanes irregularly fly to some of the larger villages. However, dog sledges are used by the settlers in the winter, and these link one settlement to the other. The sole industries in most of the littoral are fishing and trapping, though fishing seems to be on the decline, and is being replaced by various timber industries, especially in the eastern portion. The iron ore is mentioned earlier.

In 1861 there were 1,699 white settlers living along the coast between Mingan and Natashquan, and in 1931 this had grown to 5,118. Many, however, are emigrating to Newfoundland, or to the industrial centres of the west of Quebec. Almost all the villages, which contain from 100 to 500 folk each, are situated at the estuaries of the rivers. However, Havre St. Pierre has a population of 1,167, and this village lies in the shelter of the Mingan Isles, and is not

sited on a river. In the colder eastern littoral as near Harrington, there is often a summer home near the fishing, and a winter home inland near the forests, so necessary in the cold season for the supply of heat to the houses. A railway up the Moisie River now serves the iron mines at Shefferville. (See map, p. 51.)

The products of the forest have been exploited for over a century. Tadoussac and Betsiamites in the far west were invaded by the wood-cutters between 1850 and 1875. In 1883 Pentecost was opened up in the same way, and many others to the east. Many of these were abandoned later, and only three timber-getting centres remained about 1900. In 1908 a large pulp plant was established at Clarke City on the River St. Marguerite, with a railway some 6 miles long to its port at Sept Isles. By 1928 similar plants had been erected at Shelter Bay, Franquelin, Godbout, and Trinity. The mill at Clarke City with 150 workmen is perhaps the largest.

There is no agriculture to the east of Natashquan (to the north of Anticosti Island), and not much to the west as far as Godbout, where some 15 families each have a few pigs, a cow, and grow potatoes, &c. Harrington, in the far east of this coastal area, is exclusively devoted to fishing; and the thirty wooden houses—many of two stories—are built on a bare rounded rocky ridge quite devoid of trees, gardens, or any scenic amenities.

A few words may be given to the large island of Anticosti, which is about 140 miles long and 40 miles wide (Fig. 84). It is formed of early Paleozoic limestones, and is bounded by inaccessible cliffs, except at the two extreme ends of Ellis Bay and Fox Bay. It is covered with forests of the same nature as those just described for the Quebec coast. The Frenchman Menier built a railway near Ellis Bay to exploit the timber, but this project has collapsed. It seems to be too cold to grow grain, though potatoes are a possible crop. The cost of drainage is excessive, and there are only about 200 acres cultivated at Port Menier near Ellis Bay. About 450 folk live on the island, many being connected with lighthouses or employed as forest rangers, &c.

Life at Blanc Sablon—in the Far East of Quebec

One of the most complete studies of a primitive Canadian community has recently been published by O. W. Junek, entitled *Isolated Communities* (New York, 1937). It gives a summary of the sociology of the habitants along the north shore of the Gulf of St. Lawrence, and a full account of the little village of Blanc Sablon with its 13 families. From Tadoussac to Betsiamites (70 miles) there is some agriculture; for 120 miles farther east lumbering and pulp, as mentioned earlier, are the mainstays of the small villages. From Sept Iles (near Clarke City) to Blanc Sablon, over 330 miles, codfishing and sealing are the chief pursuits of the settlers. Blanc

Sablon (Fig. 82) is on the Labrador border at the eastern limit of Quebec.

At Blanc Sablon the second major occupation is the procuring of wood, which takes place in September and October. They gather the roots and timber of small scrubby conifers, and these are piled up till the snow falls, enabling them to carry them to the village on their dog sledges. November ushers in trapping and sealing. Muskrat and otter are trapped at the beginning and end of winter, for they hibernate in the coldest weather. Fox and weasel are, however, hunted through the winter. Masses of ice are carried south by the Labrador current in spring, and the seals are killed by clubbing them during March, April and May. The habitant eats the young seal, and sells the blubber and skins.

Each family unit accumulates about 36,000 pounds of dried codfish, and 70 per cent of this is available for sale, or exchange. In actual fact the habitant exchanges it at the local stores (Hudson's Bay Company or the Blais Company) for salt meat, bread, tea, and molasses. Junek is of the opinion that this trade monopoly does not work at all to the advantage of the habitant. In the 74 miles to the west of Blanc Sablon, there are six villages, all engaged in fishing, with the following numbers of families, starting with 13 at Blanc Sablon. There are 23 families at Longue Pointe, 7 at Baie de Brador 2 at Bonne Esperance, 9 at Vieux Fort, and 25 white families as well as 40 Montagnais Indians, at St. Augustin.

The interior of this vast area of North Quebec is completely uninhabited save for a few Indians, and our knowledge is largely gained from the journeys of the Government geologists. It is probable that considerable mineral wealth exists in these ancient rocks of the Shield, and indeed vast areas of iron ore are known to occur near the divide between the Hamilton and Koksoak rivers (see map on p. 51). At Moisie magnetite sands, fairly rich in iron, were worked in the nineteenth century; but the magnetite made the consumption of fuel in the furnaces too costly, and richer ores elsewhere offered too strong competition.

Along the coast of Hudson Bay and James Bay there are a few settlements such as Rupert House, East Main, and Fort George, where furs gathered in the interior are exchanged for goods at the stores (Fig. 84). A. P. Low in his Survey report (Ottawa, 1902) describes the coast north of Fort George as fringed with granite islands between which and the cliffed shore there are deep channels, offering safe harbours for small steamers. The rivers all flow to the west, and descend from the 1,500 foot plateau in the interior by a series of flat reaches alternating with numerous rapids.

Halliday describes the region as a high, well-worn, and flattened tableland covered by a scant and poor forest growth. Indeed, in

many places the ice seems to have scraped the rocks bare of soil. In general there is a light cover of stunted black spruce and balsam fir. Tamarack swamps and treeless moors, where the vegetation takes on an alpine appearance with abundance of white lichens, are common. Lakes of all sizes are very numerous, Lake Mistassini being 100 miles long. However, in some of the deeper valleys the soil is better, and here a much denser forest occurs. There does not, however, appear to be any probability of settlement taking place in this inland region, except near the new iron mines.

NATURAL REGION 15: CHURCHILL–PATRICIA

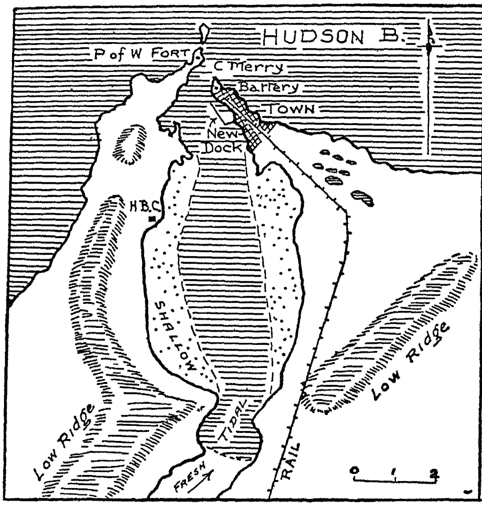
It is rather difficult to fix the boundaries of the large region which lies to the south-west of Hudson Bay. It is well beyond the settled portion of the Dominion, even beyond the transition areas for the most part, and belongs essentially to the pioneer zone. It might be defined as the basins of the Churchill, Nelson, Severn, and Albany Rivers, all of which flow to the north-east and enter Hudson or James Bays. Only one railway crosses this region, that leading from the prairies of Saskatchewan via The Pas, down the Nelson valley and then north to the port of Churchill. This is naturally the best-known and the most important part of the present region (see Endpaper Map).

The geology of this large region, which is about 1,000 miles across, is relatively simple. Most of it consists of the Canadian Shield, an area of granite rocks for the most part, but containing many large patches of Early Pre-Cambrian sedimentary and volcanic rocks. Along the coasts of Hudson and James Bays is a layer of Ordovician sediments near the mouth of the Nelson, covered to the east by a much larger layer of Silurian rocks, which in turn are covered by Devonian rocks in the basin of the Albany River (Figs. 14 and 86).

The region falls into two parts which are administered by the two provinces of Manitoba and Ontario. The western area is that served by the Churchill Railway; the eastern is often called the district of Patricia. Most of the later Paleozoic sediments are in the latter area. A fairly complete survey of the geology and resources of the latter will be found in *Report of the Bureau of Mines of Ontario* (Vol. XXI, Part II, 1912), by Willet G. Miller. It has been consulted in the following account.

As mentioned elsewhere in Chapter III (p. 42), the Shield rocks belong to various formations, of which some are more likely to contain minerals than others. In this part of the Dominion the Keewatin series often contain gold, iron and other ores, and these occur in west–east belts across the middle and south of the Severn Basin. There is also a large patch near Fort Hope on the Upper Albany

River. Limestones akin to the Grenville Series of eastern Ontario are found near Red Lake, which are promising. On a branch of the Winisk River is a large mass of hypersthene gabbro, like the nickel-bearing intrusives of Sudbury. Animikie rocks intruded by diabase —such as occur near the silver mines of Cobalt—are found at Sutton Mill east of the Winisk River, and these contain iron ore. The younger Paleozoic sediments are akin to those which contain the salt, petroleum, and gypsum in the vicinity of London, Ontario.



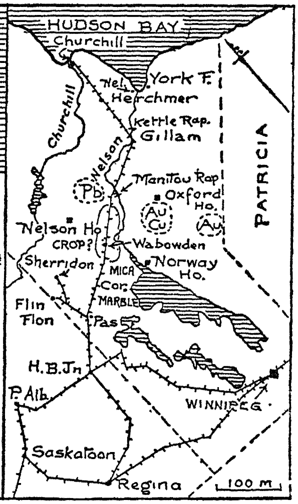


FIG. 85.—(*Left.*) The Harbour of Churchill on Hudson Bay. (Based on D. G. Ridout.) (Population 2,200 in 1951)

FIG. 86.—(*Right.*) The Railway from Winnipeg to Churchill. Possible croplands are dotted, and the mineral fields are indicated. (Based on H. A. Innis)

In recent years this area has been prospected by many mining men, often using aeroplanes based on Sioux Lookout and similar places on the railways to the south. In this way the valuable mines near Red Lake, God's Lake, Pickle Lake, and Woman Lake have been opened up. Today Sioux Lookout is the home of four airway companies, and Red Lake and Pickle Lake enjoy a daily freight and passenger service through the air. (See map, p. 51.)

In the more western region, including the basin of the Nelson River, W. McInnes (*Geol. Survey Memoir 30*, Ottawa, 1913) shows that the geology is much like that in Patricia. Rocks akin to the Keewatin and Huronian cross the region in a west–east belt from Flin Flon on Amisk Lake to God's Lake. They are mostly hornblend, chloritic, or massive, diorites with some quartz porphyries and calcareous schists.

The topography of the region is described by McInnes much as follows. The peneplain surface has an elevation in the west of about 1,300 feet, but diminishes to the east, especially in the broad Nelson basin which is the lowest portion in the interior. There are no high elevations, and the inter-stream areas are not more than 200 feet above the adjacent rivers. The river valleys are made up of chains of rockbound basins which form a series of lake-like expansions, the water spilling over the lowest part of the rims in a succession of rapids and falls. The younger horizontal limestones near Hudson Bay produce a gently sloping plain; and the level character is due in part to a mantle of boulder clay. Remarkable varve clays and an Interlobate moraine are described by J. Satterly near Sachigo Lake, 250 miles north of Sioux Lookout.[1]

The Nelson River, which empties Lake Winnipeg and runs into Hudson Bay, is 1,660 miles long. Its volume at Sipiwesk Lake is computed to be 118,369 cubic feet per second at low water. The Churchill is 1,000 miles in length, and drains about 115,000 square miles. The former river is the more important from the point of view of water-power, and some of the largest falls, each of which is estimated to be able to give over 1 million horse-power when harnessed, are as follows. Limestone Rapid (85 feet of head), Long Spruce (85 feet), Kettle (96 feet), and Gull Rapid, 67 feet of head. All of these are between 50 and 100 miles of its estuary in the Bay.

Climate and Vegetation of the Churchill-Patricia Region

The climate is extremely continental, the range of temperature amounting to 80° F. in the west and about 70° in the east. Thus the expanse of Hudson Bay does not much ameliorate the winter, partly because the winds are to a considerable degree from the west. In January the west experiences a temperature of about − 20° F., but it is distinctly warmer (about − 4° F.) along the Moose River in the east. In July there is much uniformity in the temperature, the isotherms running parallel to the coast, with a value of about 57° F. Hence this region falls within the area where some root crops can be successfully grown, though there is to date very little attempt to do so. Some of the main climatic data are given in the following table for the two extreme positions:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Churchill, T.	−19	−17	−6	15	29	42	53	52	41	26	7	−10	18° F.
Rain	0·6	1	1	1	1	1·9	1·8	2·5	2·6	1·3	1	1	17 in.
Sioux L., T.	−6	−2	12	34	48	60	65	61	54	38	22	5	33° F.
Rain	1	0·9	1·2	1·8	2	3	3 8	2·7	3·8	1·8	1·5	1	25 in.

[1] Glacial Lake Sachigo, *Journal of Geology*, November 1937.

The period of chief rain is seen to be in the late autumn throughout this area, which is of course not satisfactory from the point of view of harvesting grain crops, if oats, &c., are ever tried on a large scale. Probably the nearest homoclimes are to be found in eastern Siberia in the upper basin of the Amur River.

The forests of this large region vary a good deal, chiefly in regard to the character of the drainage and underlying rock. The climate is suitable for the usual trees of the Taiga, and black spruce is the dominant tree throughout. Halliday divides the region into three sections, as follows. In the Albany basin in the south, where the winters are less severe, and where the rocks are Paleozoic limestones, &c., the river banks are the best-drained areas. Much of the rest consists of vast muskegs, which never contain large trees owing to the almost complete lack of drainage. Hence mature podsols form only on the river banks. Black spruce and tamarack are the chief trees, but are not of large size over much of the region. White spruce, balsam fir, and various poplars are of secondary importance.

The interior of Patricia has been intensely glaciated, and the soils in consequence are rather thin, so that a poor growth of black spruce is characteristic. On the drier sites are considerable stands of jack pine, while tamarack as usual is common in the swamps. White birch is not uncommon, but Halliday places the limit of merchantable timber at about 200 miles from Hudson Bay. Along the coastlands from James Bay to Churchill the trees become more stunted as the tundra broadens. Under these conditions the trees are confined to the river banks, and tundra spreads on the less-sheltered portions. Black and white spruce are the chief trees, but tamarack dominates large areas in the north (Fig. 114).

Scattered through this vast territory are a few mines of recent origin, the chief of which have already been mentioned, and a number of old established fur-trading posts. These are naturally found mainly at the mouths and along the course of the rivers. Commencing at the south we find Moose Factory and other small settlements, such as Coral Rapids and Smoky Falls, on the Moose and its tributaries. Next in the Albany Basin, Fort Albany is on the coast, and Osnaburgh House on the headwaters near Lake St. Joseph. There are also several posts opposite the large Akimiski Island. On the Severn are Fort Severn, and at the mouth of the Hayes and Nelson the important York Factory and Port Nelson. Near the head of the Hayes are Oxford and Norway Houses. The settlements along these northern rivers have been greatly increased in number owing to the new Churchill Railway, which will now be described.

The Churchill Railway and the Hudson Bay Route

We owe to H. A. Innis an unusually complete study of the economic aspects of this new route between the prairies and the Old World (Fig. 86). It is to be found in the *Geographical Review* (New York) for January 1930. During the early days of the fur trade the Hudson Bay route reigned supreme as regards the collection of furs around the bay, but the opening of the Red River route in 1859 challenged this supremacy, and with the building of the railways, which reached Winnipeg in 1879, more and more of the trade of the Patricia-Churchill area was deviated to the St. Lawrence outlet. Moreover, the wheat traffic was vastly more important than fur, and the railways were open all the year, whereas the outstanding feature of the Hudson Bay trade was the long, closed season.

In 1908 a railway was built from Winnipeg to The Pas (*pron.* 'Paw'). The new provinces of Alberta and Saskatchewan had been created in 1905, and they exercised considerable pressure in support of the new short route to Europe. In 1913 some 18 miles of the railway to the coast was completed, and at this time they were aiming at Port Nelson as the port of entry. By 1917 the grade levels had been made right to this port, though rails were not laid. The war pushed the railway into the background, and little was done until 1926. A final survey of the proposed ports by various engineers led to Churchill replacing Nelson as the terminus of the line. This change was chiefly due to the deeper water at the northern port, and Nelson was abandoned after 6 million dollars had been spent at that site.

In October 1929 the last rail from Winnipeg to Churchill—a distance of 978 miles—was successfully laid (Fig. 86). It is of interest that almost the whole of the northern portion runs on embankments, which raise the railway above the general muskeg levels. Very extensive work was necessary at Churchill to convert the rather shallow mud-floored estuary into a modern port, with facilities for storing and transferring large quantities of wheat. The town is built on the long low rocky promontory on the opposite (east) side of the estuary from the Hudson's Bay Store and Royal Canadian Mounted Police station (Fig. 85). At the mouth of the harbour on the west side is the old Prince of Wales Fort, built of solid masonry between 1733 and 1771. This was one of the strongest forts in America, and was 300 feet square with walls about 40 feet thick.[1] All of the original guns are still lying alongside the ancient walls. From this fort Hearne was sent to explore the

[1] For an interesting account of old and new Churchill see the illustrated article by D. G. Ridout in the *Canadian Geographical Journal* for August 1931. The paper by Baird and Robinson (cited on p. 24) gives recent photographs. Several posts have been moved to the *east* side.

northern coasts (1769–72), and his name can still be seen carved on the rocks. In 1782 Fort Churchill was captured by the famous French navigator La Perouse, but was soon restored to Britain.

The great advantage of this new port is that wheat from Saskatoon and the vicinity (Fig. 86) can reach Liverpool in England over a route of only 3,814 miles, whereas via Montreal the total journey is 4,878 miles. The Hudson Straits are free from ice for about three months after the middle of July; and if ships arrive at Churchill early in August they will be well ahead of the arrival of the season's harvest at Churchill. In the decade or so since the docks were ready there have not been as many ships using the port as was expected. For instance, in 1940 there were only six vessels (with an average tonnage of 3,000) which entered and cleared from Churchill. However, the Second World War caused a great diminution of trade, for in 1933 there were ten vessels, with an average tonnage of 4,700. (In 1951, 21 ships.) Ice conditions are discussed on page 293.

In the paper by Innis, quoted earlier, he points out that trade of a local nature will in time help this railway. There are important mines at Flin Flon, just on the edge of the Shield, and good prospects of silver-lead are known near Nelson House, while gold and copper have been reported from the Shield near Oxford House (Fig. 86). Marble and mica have been worked between the railway and the north end of Lake Winnipeg. Lands of some value for agriculture are known to occur between Cormorant and Manitou Rapids. The large amounts of hydro-electric power along the Nelson River have already been described. (Wheat export is charted on Fig. 144.)

Moosonee, South of James Bay

In concluding this description of the lands bordering James Bay, some mention must be made of the interesting settlements at the mouth of the Moose River. The district has been described by J. Q. Adams in the *Scottish Geographical Magazine*, July 1939. He points out that here we have two contrasting types of settlement, as is so often the case in expanding Canada. Moose Factory was where sheet iron used to be converted into useful articles for Indian trade, hence the name 'Factory', and was founded as long ago as 1671. Indeed, it was the second post founded by the ancient Hudson's Bay Company. Today some 4 miles to the west is Moosonee, which is a new railway port like Churchill, and was built as late as 1932 as an outlet for white settlement to the south (Fig. 84).

Moose Factory served well enough in the early days of the fur trade, for small vessels were adequate for the times. But as bulky articles, manufactured in the factories of Britain, were sent out for the Indians the ships were too large for the 8- or 9-foot channel.

Hence the main entrepôt of James Bay was shifted in 1904 to Charlton Island about 60 miles north. Today some of the larger buildings at Moose Factory are empty, for only a small fur trade from the immediate river is now based on the Factory. However, the Mission schools of the Anglican and Catholic churches, and the Royal Canadian Mounted Police station still remain at Moose Factory.

Moosonee was sited where the river bank is high enough to be free from ice jams and floods, and here the railway reaches tide-water. Here also is a small tourist hotel, and the new store of the Hudson's Bay Company which has been drawn here by the advantage of the railway (Fig. 151). Charlton Island has therefore already lost much of the importance it acquired in 1904. The shores of James Bay are so shallow that there is not much probability of coastal trading *along* the bay, adding to the importance of Moosonee as a collecting centre for local products. Some lignite deposits of Cretaceous age are known in the Onakawana district south-west of Moosonee.

Meteor Crater

In 1950 a crater, probably due to the impact of a huge meteorite, was discovered near Hudson Strait, about 100 miles east of Cape Wolstoneholme (Wol. in map, p. 242). It is four times the size of the well-known crater near Winslow, Arizona; and it rises 500 feet above the tundra.

CHAPTER XI

WESTERN PIONEER LANDS

NATURAL REGION 16: THE MACKENZIE BASIN

Structure and Geology

AT first sight it would seem unlikely that this huge basin, extending from latitude 55° almost to 70° N., would be homogeneous enough to constitute a single region. But a consideration of the temperature lines in the summer and of the resultant vegetation (Fig. 21), shows us that there is very little change in the environment from McMurray in the south to Aklavik in the Mackenzie Delta. The writer had the good fortune to make a fairly detailed survey of this area in the summer of 1944, at the instance of the Social Science Research Council. It is of the greatest importance to Canadians, since it represents the last frontier of potential arable lands in the Dominion.

In an earlier section it was shown that the Mackenzie occupies the centre of the main Downfold, between the Shield on the east and the area of Young Mountains on the west. The great river itself illustrates the dominance of the north-west to south-east grain of the country, and this same feature is emphasized by the remarkable series of great lakes, from Ontario to the Great Bear, which occupy the lowest portions of this vast extent of territory. It is worth noting that the edge of the Great Canadian Shield runs near this line of large lakes, and there is little doubt that in some degree the lakes are held back by the cuestas, formed where the younger rocks cover the great Shield on the west.

In the northern part of the area under consideration, we see many examples of this north-west to south-east grain, in the form of river valleys, &c., which seems to indicate minor undulations in the earth's surface—not large enough to be called downfolds, but obvious enough in the landscape (Fig. 87). One of these is occupied by the Mackenzie River; another about 250 miles to the east runs along the Anderson River, links the Great Bear Lake to the north arm of Great Slave Lake, and continues south by the Slave River and lower Athabasca. The Coppermine River and lakes at its head perhaps indicate another undulation of the same type.

The great Athabasca-Slave-Mackenzie waterway flows north in a broad low basin or downfold, so that the voyager sees no hills of note until he arrives near latitude 63° N. at Fort Wrigley.[1] Hills

[1] A lengthy account of this survey (made in the summer of 1944) appears in an article 'Mackenzie Domesday, 1944', which I contributed to the *Canadian Journal of Economics*, May 1945.

are evident on each side of the river at Norman Wells, but nowhere are there considerable mountains near the river, such as for instance is the case along much of the Yukon River farther to the west. From the air one sees an enormous area of Taiga—a velvety expanse of spruce as it seems from 2 miles up—with patches of smoother

FIG. 87.—Vegetation in north-west Canada showing the edge of the Tundra, and of the Shield; also the Alaska Highway. Posts on the Mackenzie River are shown by initials. (Forests after W. E. D. Halliday)

green muskeg and great numbers of irregular lakes. Away from the rivers and the edges of the great lakes, there is no settlement in this enormous area.

This fact makes a detailed study of the small settlements which have developed along the main corridors of great significance. Such

a place as Fort Smith resembles Montreal as it was in the seventeenth century. Like Montreal, it has grown up at the lower end of a long series of rapids. These, in both cases, are due to a big river cutting down into a narrow extension of the resistant Canadian Shield (Fig. 87). Fort Smith is the head of navigation, and as such must grow much larger than it is today, and no nearby settlement has such a good situation, or can hope to rival Fort Smith. The same is true of many other of the river ports, scattered at intervals of about 50 miles along the Mackenzie. Most of them hold key-positions at the mouths of the main tributaries. Their histories are therefore of much more significance than those of similar small villages in the southern exploited parts of the Dominion.

The main geological formations encountered on this journey of over 2,000 miles to the north can be disposed in a fairly simple fashion. Devonian or allied rocks border the river almost all the way from McMurray northward to the Blackwater River in latitude 64° N. From this place (near Wrigley) to the beginning of the great Delta alternating belts of Devonian and Cretaceous rocks are encountered, each about 50 miles wide. There is naturally a tendency for the softer Cretaceous rocks to flank rather broader sections of the river, while the harder old rocks give rise to rather narrow portions of the river; and at the 'Ramparts' determine almost the sole picturesque portion of the Mackenzie.

The Climatic Factor in the Mackenzie Basin

With meteorological stations confined largely to the river, with a few at the mines to the east, there is not much chance of preparing reliable climatic maps. The writer has, however, endeavoured to draw a map showing the Advent of Spring of the same type as one he published for southern Ontario. In this case the daily temperature of 42° F. is chosen as indicating the arrival of spring. Trees begin to show leaves, and plants in general grow readily, since the plant-cells 'wake up' as this temperature arrives. We see from the isopleths on Fig. 88 that spring comes to Fort Wrigley (north of 63° N.) as soon as it does to Gaspé in latitude 49° on the shores of the Atlantic. In both cases the first day to record an average of 42° F. is the 15th May. F, F, F on Fig. 87 shows the limit of frozen soil.

On the same map is expressed the period between the onset of spring and the return of the same average temperature in the fall. There is, of course, a simple relation between the two functions, which can be expressed in the straight-line equation

$$X = 113 - 0{\cdot}565\ Y$$

where X is the number of days after April 1st (to the day with 42° F.), and Y is the number of days between the spring day of 42° and the fall day of 42°. We find that Aklavik has about 70 days of warm

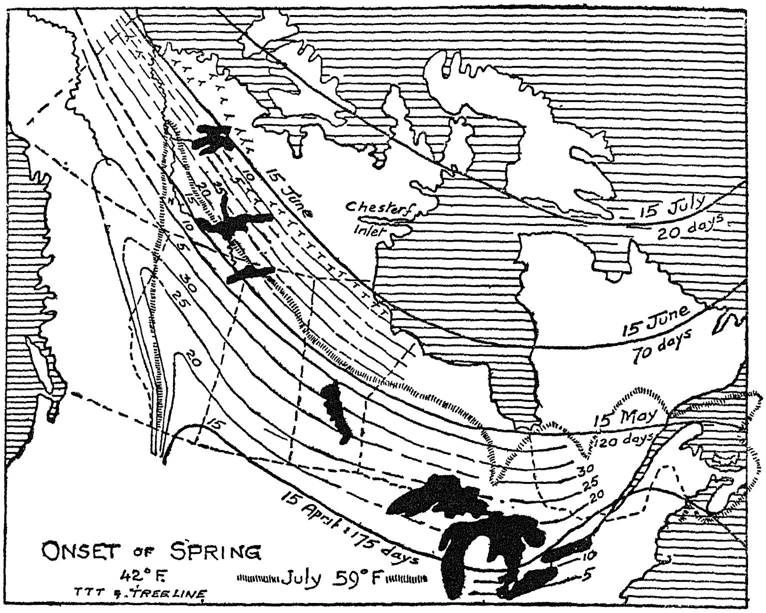


FIG. 88.—The onset of spring is indicated by the day on which an average of 42° F. is first recorded. Note that Fort Wrigley has spring weather as soon as Gaspé. The length of the warm period is also noted. The tree-line (T.T.T.) and the July isotherm of 59° F. are charted

weather (as defined), and so has a growing season long enough for many northern crops. Of course, this formula takes no account of the variability of the temperature, nor of unseasonable frosts which are a real danger in the Mackenzie valley, nor of the rather low total rainfall. We can summarize the climate of the Mackenzie area as being very like that of Newfoundland (except in winter, which is not very material as regard crop capabilities).

The map in Fig. 89 is an attempt to fill in some gaps in the official map published by Brooks and Connor. The isohyets for 11 and for 13 inches are fairly accurate, I believe, but I have only estimated what the values are in the mountain areas in the west. (The rains are bound to be heavier here, but there are no meteorological stations.) Since Aklavik and Good Hope have only about 10 inches of rain, it is unlikely that most of the flat Tundra to the east has a much greater rainfall. Accordingly I have labelled all this unknown area as receiving about 10 or 11 inches. It has no possibilities of crop growing, as the natural vegetation—that grand index of settlement—shows quite conclusively.

I add to the map (Fig. 89) the very important line showing the

FIG. 89.—A tentative map of the rainfall in north-west Canada. The 11-inch isohyet is fairly accurate, but the 15-inch isohyet is only a rough estimate. The probable limit of root crops is indicated at the Tundra edge

possible margin of ' root crops '. This is taken from the valuable study issued at Ottawa entitled *Canada's Western Northland* (1937). This ' root-crop line ' runs from Aklavik to Churchill, approximately at the edge of the Tundra. The reader is invited to notice the vast interval—about 400 miles—between this line and that showing the northern boundary of the wheat lands. It is in this marginal area that most of the expansion of Canada's settlement must take place. Hence it is to the Mackenzie valley rather than to the Shield areas in the north of Ontario and Quebec that we must turn our eyes, when we try to picture Canada's future.

According to Halliday the forest cover all along the Mackenzie north of McMurray has a very uniform character. He makes it one forest unit, which he names the ' Mackenzie Lowland Section ' of the boreal Forests. I cannot do better than quote his general description of the whole area.

The prevailing forest cover appears to be coniferous, with white spruce the major dominant, forming pure associations. Extensive fires

have, however, favoured the admixture of aspen, balsam poplar (balm of Gilead), and Alaska white birch with this species, and the occurrence of jack pine associations on the lighter soils. On the better-drained alluvial soils such as old river banks, well-developed stands of balsam poplar are very characteristic, and the poorer drained sites support numerous shallow black spruce and tamarack swamps, and large areas of wild hay meadows and willow scrub. Records would indicate exceptionally good growth for the majority of the species, where the drainage is good, and this condition continues even down to the Arctic Circle.

There is little doubt that there are large swamps away from the banks of the big river. The cost of draining such large areas, even if the soil be suitable, is beyond the resources of the pioneer, and will have to be done in the distant future by the Government. However, the rainfall is lower here than in corresponding pioneer lands in Ontario and Quebec, which may make this particular drainage problem less difficult in the Mackenzie basin.

I had anticipated that the trees would diminish in size quite regularly as our latitude increased, but this was not the case. I measured trees at Providence (61° N.), which were larger than those I saw at Fort Smith far to the south. At Gillies Landing, north of the Circle, I measured a spruce about 5 feet from the ground with a diameter of 18½ inches. At Aklavik (68° 16′ N.) the older stumps showed that trees there were 20 inches in diameter, though those still standing seemed to be about 16 inches.

Traverse from Edmonton to the Rapids at Fitzgerald

For some 30 miles north of Edmonton the country is undulating and largely converted into farmlands, so that the little town of Bon Accord has custom for four wheat elevators (Fig. 81). Around Egremont the region is flat, but still largely farmland, so that this is a 'three elevator' town. But Newbrook (72 miles north of Edmonton) had only one elevator on my visit in 1936. The clearings now became much scattered, and much of the landscape consisted of grass below scrubby pines, with many copses of poplar. Boyle has two elevators and an hotel. At Bondiss there were twelve families at that date, of whom four were on farms. Here they grew barley, oats, and some wheat, and the population was mainly Lithuanian and Swedish.

Lac la Biche at 132 miles is practically the vanguard of agricultural settlement. It is, however, a tourist centre, owing to the attraction of a picturesque lake. Here are two or three hotels, four stores, and a dozen other shops, together with a large tourist home and a pretty church on the shores of the lake. I saw only one farm close to the town, but there are others in the vicinity. North of Lac la Biche the railway serves Cree Indians for the most part. They

live in log-houses when they come in to the railway, and are engaged in trapping and in fishing in the lakes. Conklin is perhaps the chief settlement between Lac la Biche and Waterways, but it contained only two stores and about a dozen Cree huts. Much of the land was now scrubby spruce and muskeg, but on the higher land poplar with trunks a foot in diameter flourished. In 1936 the train journey to Waterways took 27 hours; but today (1945) the journey takes only about half as long.

The character of the topography in the vicinity of Waterways and McMurray can be clearly made out from the sketch given in

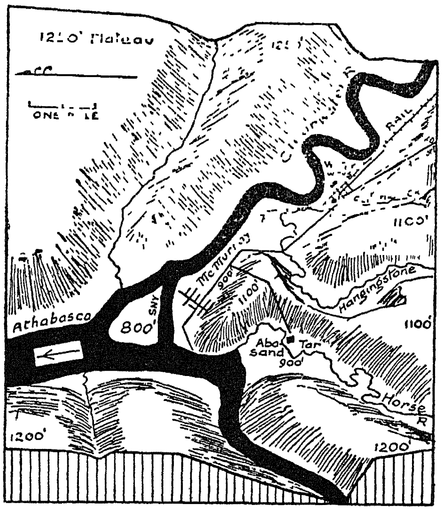


FIG. 90.—Block Diagram of the vicinity of McMurray, showing Waterways, Prairie (Pr.), and the salt and tar-sand deposits. Looking to the east

Fig. 90. We see that the rivers have cut down about 250 feet into the surface of an undulating plain or low plateau, whose general elevation is about 1,250 feet above sea level. Possibly the flat floors of the main valleys date back to the last glacial age, while the meandering streams of such a river as the Clearwater represents the lessened drainage of these drier times.

When the writer first visited McMurray in 1936, the airport was in the Snye channel just north of McMurray. Three companies were sending out ten planes to the mining camps in the Great Shield to the north. The airway offices were mounted on runners, so that they could be dragged away from the river in the usual fortnight of floods in the spring. These floods are due to the northern ice thawing much later than does the frozen river at its southern head-

waters. There are similar floods in the fall, as the northern portions freeze before the headwaters. For the last few years, however, a land airport has been in use, about 8 miles to the south-east of Waterways, and this transition from water to land ports is common in the northern air services.

Waterways is 3 miles from McMurray, and is the creation of the railway, which reached this area about 1920 and here touched navigable water in the Clearwater River (Fig. 90). Hence the railway did not proceed to the older centre of McMurray, where the fur-traders had a post in 1790. Between the two is 'Prairie', where the U.S. Army once had a huge storage centre of material needed for the Canol Project at Norman Wells. Today Waterways has five or six stores, two churches and a fine school, all of which have been erected in the last eight years. Here are the offices of the three trading companies; and here the stern-wheelers are tied up, which carry the cargoes north to the rapids at Fitzgerald. There are a number of salt wells at Waterways, and a fair-sized chemical plant has been erected to work the salt. There is also a fish cannery to process the fish caught in the lakes and rivers.

McMurray is a more imposing village, though it is not growing so rapidly as Waterways. Here are the fur-trading offices and the larger Hudson's Bay Store. The radio and airway offices are here also; and there are several churches and two large schools. In recent years the Catholics have built a brick hospital. The permanent winter population of each town is about 300; but it is much greater in the summer, when the Indians come into the villages and occupy rather ancient shacks on the margins of the settlements.

Wheat and oats grow satisfactorily in the district, and several acres of potatoes have been cultivated by a Japanese family for many years. Roses flower, but tomatoes must be protected from frost. All along the Athabasca River are outcrops of tar sands, and these are being excavated in an open quarry a mile or two south of McMurray. In the aggregate, a vast amount of tar and petroleum is contained in these sands, but their extraction is not easy, nor can we be sure yet as to the value of the deposits. However, some folk believe that the McMurray Tar Sands constitute one of the greatest assets in the Dominion.

There are no settlements of note between Waterways and Fitzgerald, and most folk fly across the region between the two centres. At Fitzgerald the Mackenzie cuts its way through an extension of the hard granite Shield, and hence the river descends over 100 feet in five rapids.[1] The main wharf where the Athabasca boat ends its journey is on the west bank just above a high bluff of granite. Today

[1] Functional plans of Fitzgerald and all river-ports to the north appear in my article in the *Canadian Journal of Economics* for May 1945.

all cargo is transferred by lorries to the boats at Fort Smith; but in the early days horses and oxen were used, and these were kept at the Half Way Station, where there were open meadows. Cattle are grazed here today, before being taken north to the mining fields at Yellowknife and elsewhere. Fitzgerald is a small, straggly settlement with about 30 white settlers and perhaps 100 Indians.

Two roads lead to Fort Smith, one much improved by the American Army. It is the metropolis of the upper Mackenzie basin, and is quite a pleasing northern town (Fig. 91). In the early days a Catholic Mission was established just where the Indians coming up

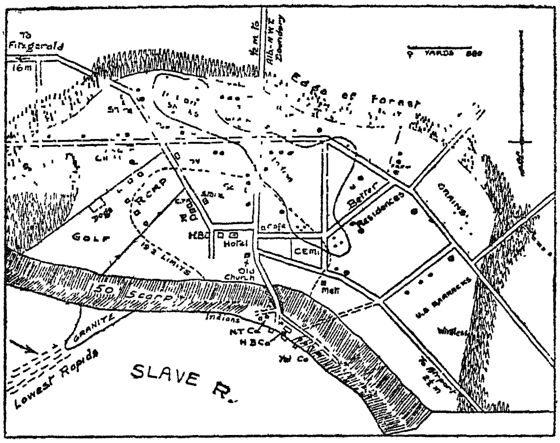


FIG. 91.—A functional plan of Fort Smith, the main town on the Slave River. The broken line shows the limits in 1912; and the continuous line includes the modern Indian shacks. Fitzgerald is 16 miles upstream.

the river drew their canoes to the shore. Today the town is built up on the terrace about 150 feet above the river and centres about the large hotel and store owned by the Hudson's Bay Company. The old Portage Road now winds rather irregularly through the little town from the south-east corner, and most of the chief buildings are close to this road. The most extensive group belongs to police, in whose grounds is a golf course. Nearby is the Anglican Church and the Government Offices. There are several stores besides the Hudson's Bay Company, as well as the post office and the large Catholic Mission. The most imposing building is the three-storey Catholic Hospital, and back of this are many acres of oats, &c., as well as barns and other farm buildings belonging to Ryans—the transport company which carries cargo from Fitzgerald. Down at water's edge are the big warehouses of three or four trading companies; and from their wharves start the various launches, stern-

wheelers, and scows which carry cargo to the north. A large airport has been built 2 miles west of the town.

Great Slave Lake, Hay River, and Providence

My five weeks' voyage was taken on the *Distributor*, a stern-wheeler of 800 tons, which is the largest boat of a fleet of about a dozen operated by the Hudson's Bay Company. She draws only about 4 feet, and as she possesses four decks, the top hamper makes it impossible for her to traverse open lakes or open water without drifting dangerously, in spite of the five rudders flanking the stern-wheel.

There is little in the way of scenery between Fort Smith and the Great Slave Lake. The shores are formed of river silt, usually with banks from 10 to 20 feet above the river. A low scrub of willow often covers the banks for a quarter-mile or so, with a broad outer fringe of poplar between the willows and the universal spruce of the Taiga. The boat went downstream, with the current and engines operating together, at about 8 knots; and every few days it was necessary to tie up and take aboard the cordwood which served as fuel. This is piled up in great heaps by a few isolated woodcutters to await the steamers. (Oil fuel is replacing cordwood.)

The steamer has a broad flat prow with which it pushes the main scow ahead of it. Lashed firmly on each side of this scow is another scow, and often on the down voyage there are two smaller scows ahead of the three already mentioned. On reaching narrows or rapids in the river, and there are a fair number of such, it is necessary to take the scows ahead one at a time, so that all day is sometimes consumed in advancing north only a few miles.

At the north end of Slave River where it enters Slave Lake there is a little new settlement called Res-Delta. Here scows and piles of timber, &c., were waiting to be taken across the lake to Yellow-knife as occasion offered. Fort Resolution lies west of the delta, and the *Distributor* did not call there on this occasion. We had to wait some days near Res-Delta, sheltered by some islands, until the weather was calm enough for us to reach Hay River settlement to the west. At this latter place the winter road from Grimshaw on the Peace River railway reaches the Slave Lake. In the winter sledges, &c., can cross the lake and proceed westward to Fort Providence.

At Hay River there used to be a large Anglican Mission and church, with a three-storey school and a hospital (Fig. 89). Today only the hospital is in use, though the Catholic Mission seems to be flourishing. Several hundred Indians live in the settlement in huts and tents during the summer; and early in July they collect for the 'Treaty Money' (five dollars a head) which is distributed by the

government agent at this time of the year. Fish are abundant in the vicinity, and the Indians catch large numbers of whitefish, pickerel, and 'inconnu'. Much of this forms the food of their dogs, of whom there are about 200 chained up during the summer all over the village.

Fort Providence had much the same appearance as Hay River, though the cut-bank (river bank) was considerably higher, and showed the remains of a former ancient 'oxbow meander' perched up above the present river. Here were two Catholic churches, a huge three-storey school for the Indian children, and a large barn. Several acres of potatoes, oats, and wheat, surrounded the Mission, and all were growing well. At intervals along the cut-bank were the neat buildings of the Hudson's Bay store, the radio engineers, and at the further end of the settlement the cluster of buildings belonging to the Mounted Police. The white folk are distributed somewhat as follows. There are four priests and a dozen sisters at the Catholic Mission, five members of the staff at the new airport, four at the wireless station, five at the store, and two police officers. Two white trappers make this their headquarters when they are not trapping. There is also a small store owned by a Syrian, giving a total of about 40 white folk at Fort Providence.

The wheat was about 14 inches high on the 1st July, and some was already in full ear, though the dry spring is not favourable for grain. Seed is sown the last two weeks of May, and they reap early in September. The French priests have several cows, which are kept in the barn until the 25th April, and then they stay out in the open until early in October. There are fair natural meadows about 5 miles away.

Just above Simpson are the Rabbitskin Rapids, where the floor of the wide river seems to be paved with huge boulders, leaving only a narrow channel in which the current runs at 8 knots. The river soon expands from about one-third of a mile wide to about two miles at Fort Simpson (Fig. 95). There are about 45 white residents, and the general plan is much the same as in the posts already described. Fort Wrigley was established later than most of the other posts in 1880, but in spite of a history of some 65 years, it only contains six whites. However, there is no other post in the 300 miles separating Simpson from Norman, so that it is probable that it will grow considerably when the tide of population begins to turn northward.

Fort Norman, Norman Wells, the Ramparts, and Good Hope

It is worth noting that the sole patch of snow which I saw at low levels in my long journeys in northern Canada was on the river bank near the Blackwater River at 64° N. In the following weeks

I travelled some 400 miles nearer the Pole, but everywhere were spruce trees or tundra flowers, and never a sign of snow or ice.

Fort Norman is rather picturesquely situated on the narrow promontory between the Mackenzie River and the Great Bear River which drains the Great Bear Lake. Here a number of small launches link with the valuable radium mines on the eastern shore of the Great Bear Lake, and scows laden with radium concentrates were awaiting transfer of their load so as to reach the refinery at Port Hope on Lake Ontario. The little post at Fort Norman is built on two river terraces, one 20 and the other 45 feet above the river. As usual, the Anglican Church was closed, and the Catholic Mission was serving the religious needs of the small community. About twenty whites, including six women, live at this centre of civilization in the north (Fig. 95).

At Norman Wells some 40 miles farther down the river there was a flourishing community of over 1,000 whites; all drawn there by the discovery of a petroleum field of promise. Seepage of oil on Bosworth Creek had been known since the early days, but the first well was put down in 1920. Commercial oil was encountered at 723 feet, and it is now producing about 100 barrels a day. There are about five dozen wells in the vicinity of Bosworth Creek, some on the mainland, others on the nearby sandy islands in the river, which is here 4 miles wide.

There are two separate towns connected with the oilfield; on the east bank near the wells is Norman Wells, while the other is called Canol, and is on the west bank about 4 miles from the river and some 8 miles to the north-west of the original oil well. At this latter settlement were the main American offices connected with building the road and laying the 4-inch pipe over the mountains to Whitehorse, some 600 miles to the west. (They are now abandoned.)

Norman Wells, with its four or five hundred whites, is a very interesting town. It spreads for a mile along the banks, and may be divided into four parts (Fig. 133). At the south end is the large airport, where planes left every day for Edmonton and other southern towns. Then at the main wharf is the large two-storey wooden hotel, which is under the control of an American army officer. Alongside is the huge mess hall where all the population eats. There is also a community hall and a Commissary in the 'plaza', but no church or school. The latter is hardly needed, since there are no children in the community; and though there are a number of women they are all employed by the oil companies, engineers, or Army. Then further to the north is the site of the engineer's shops and store-yards. Here are to be seen some of the largest bulldozers and grab-all carriers in use in America. Still further to the north are the wells, and the numerous silver-painted

tanks which temporarily house the oil. If, as recent reports state, this whole project—started to help in the defence of Alaska primarily—should be abandoned, then Norman Wells and Canol will return to the stagnant condition in which they existed previous to 1940.

About 30 miles downstream from the oil-wells the hard Devonian rocks, which include the oil-bearing beds, give place to soft Cretaceous formations with a corresponding widening of the river. About 10 miles above Good Hope another belt of Devonian rocks leads to the constriction of the big river in a gorge only about 500 yards wide. This abrupt cliff of hard rock, bounding the narrow gorge, is

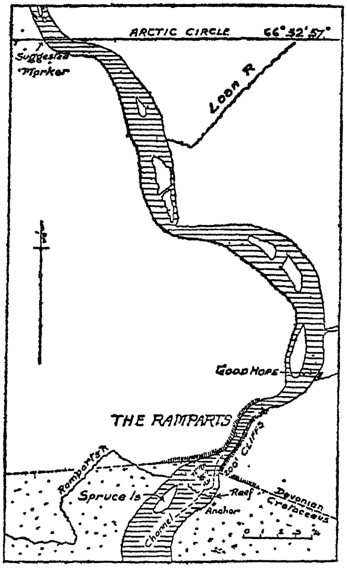


FIG. 92.—Map of the Mackenzie River near Good Hope, showing the Rapids at the Ramparts and the position of the Arctic Circle

known as the Ramparts (Fig. 92). A rather difficult rapid occurs just above the Ramparts. At very low water there is a real drop of about 20 feet here, and on occasion steamers have been held up for as much as 28 days trying to ascend the river. At times a strong cable has been fastened to the shore, and the steamer hauls itself up this ascent; but when the river is high the rapid is barely visible.

Good Hope has been built on a high narrow promontory between the big river and a small tributary, the Jackfish, which enters on the east side (Fig. 92). There are two stores here, besides the usual Hudson's Bay store, and many Indians make it their headquarters. Unfortunately a very large proportion of the Indians here are afflicted with tuberculosis, and in the last two years there had been

70 deaths of Indians, mostly under 40 years old, and only 20 births. Gardens were numerous and flourishing at this post less than 20 miles from the Arctic Circle. The Hudson's Bay Company manager grew plentiful supplies of turnips, beets, cabbage, carrots, peas, lettuce, beans, onions, radish, and spinach. Potatoes, of course, do well, and were flowering freely at the time of my visit. A somewhat unusual feature was the close-set row of substantial wooden houses along the crest of Jackfish Creek in which the Indians lived during the summer. There is a large Catholic Church and Mission House here, but no Anglican community.

The *Distributor* crossed the Circle about 2 a.m. on the 13th July on her first voyage north in 1944 (Fig. 92). It was an interesting event to the writer, who has had two years' experience in the Antarctic, where nothing but a very rare patch of moss on an occasional outcrop of dark rock enlivens the scenery of snow and ice. Here at Gillies Landing—where we stopped to take fuel on board—were three long rows of stout spruce logs, all cut in the vicinity. Behind on the margin of the dense Taiga forest, I collected within a few yards of the ship, alders, wild currant, mooseberry, purple fireweed, yellow cinquefoil, purple paintbrush, yarrow, shepherdia, and a purple pea, besides others I could not identify.

Arctic Red River was the next post on the river, and here the buildings are scattered along a rather high ridge, which surrounds a pretty little pool. Growing on the banks of this were small white Calla lilies, while the slope was a blaze of purple fireweed. There are only half a dozen white folk at the post, including two priests who serve in a picturesque church perched high on the end of the ridge above the river.

Less remarkable in its position was the next stop of the steamer at Fort Macpherson (Fig. 93). It lies on a tributary, the Peel, and used to be of importance as a station on the short route to the Yukon, by way of the Rat and Porcupine Rivers. About 300 Loucheux Indians make this their headquarters, and the place is notable for the fact that here the Anglicans have sole control, though a Catholic mission house was just being built when we were there. (Fig. 95).

Aklavik and the Delta of the Mackenzie

Twenty miles north of Arctic Red we reach the head of the great Mackenzie Delta. This seems to be unlike other deltas observed by the writer; since the problem of deposition by a large river is complicated by the vast deposition of glacial material along the northern coasts, as apparent at Tuktoyaktuk. The southern part of the delta therefore shows the usual branching distributaries of a large river entering the ocean. But the northern portion has a much more undulating surface, and is further diversified by the

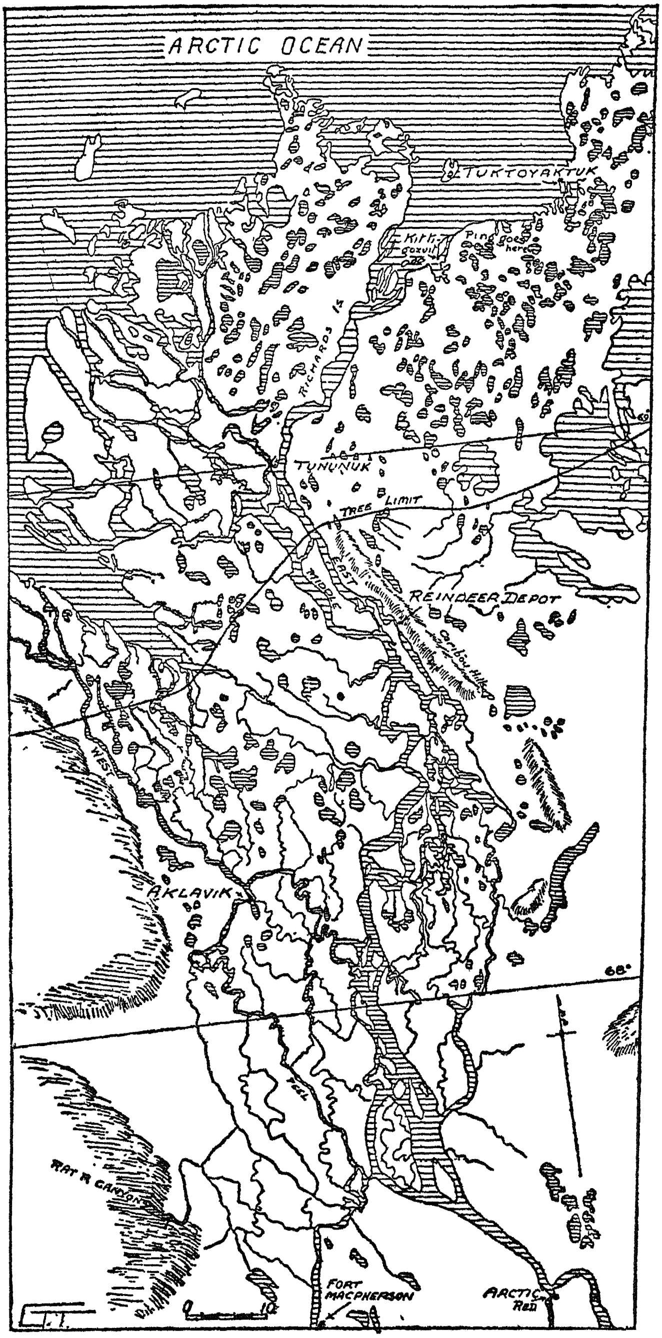


FIG. 93.—The Delta of the Mackenzie, showing the 'lake and mound' topography north and north-east of Tununuk. The edge of the Tundra is shown. (From the official charts)

unusual 'ping-goes' or mud craters. Tununuk, at the southern tip of Richards Island (Fig. 93), seems to mark the boundary between the delta and the glacial 'lakeland'.

Strictly speaking, therefore, the delta of the Mackenzie fills a long wide gulf, about 125 miles long and 50 miles wide. It is fairly definitely bounded by the Caribou Hills on the east side, which rise steeply for about 500 feet behind Reindeer Depot. Still wider highlands come close to the delta on the west. The Rat River has cut a deep gorge through the fault scarp of these Richardson Mountains, as is indicated in Fig. 93. Half-way down the delta there are three fairly well-defined channels as well as the innumerable anastomosing branches of other small distributaries. The main channel seems to keep mainly to the east side of the infilled 'gulf'. Near Reindeer Depot it splits into an East and a Middle Channel, of which the former has the major opening to the Arctic Ocean. Near Tununuk it turns to the north-east, and seems to follow a slight downwarp in the Lakeland area. Its shores within the treeless lands of the Tundra have a different topography from that of the delta proper, as can be seen from Fig. 93.

The West Channel seems to be a continuation of the meandering Peel River, whose channel links with an important arm of the Mackenzie at Aklavik. The West Channel enters the Ocean west of meridian 136°, and no main channel opens into the well-marked bay shown in Fig. 93. It is to be noted that these delta islands alter in shape rather rapidly, and the last surveys (1943) differ a good deal from those issued previously. If the explanation given is correct, that the lakeland area north and north-east of Tununuk does not result from river deposition, then the Mackenzie has not built a conventional triangular delta out into the sea, as has happened in the case of the classical delta of the Nile. The river has probably been filling the northern end of one of the north-west to south-east depressions (drowned by the sea) mentioned in the first section of this study.

The banks are low, built of alluvial material, and forested with spruce and willows. Northward the banks gradually diminish in height and the forest growth decreases and gradually disappears. The depth of the Eastern Channel is not less than 5 feet anywhere throughout its length. The great lakes along the Mackenzie collect much of the normal silt, so that the delta is only slowly being built into the sea. They also regulate the flow of the river, and according to McConnell the average discharge is about 500,000 cubic feet per second (Camsell and Malcolm).

En route from Fort Macpherson to Aklavik the boat stopped to collect fuel from the forest in the delta. Here the trees were of about 16-inch diameter, and grew upon a dark loamy sand. The banks here in latitude 68° N. were about 20 feet above the river. We

tramped some distance into the forest, and were greatly annoyed by the immense numbers of mosquitoes. We landed at A-klàv-ik at 7.30 a.m. on 17th July. This settlement is the metropolis of the north, for there are about 170 white folk, 213 Indians, and 377 Eskimos in this district (Fig. 94). The settlers were waiting on top of the 15-foot cut-bank, and it was not easy to distinguish Indians from Eskimos. Today the men have all adopted white-folk clothing, though they may wear a fur collar on their jerseys. However, the native women, whether Indian or Eskimo, all wear long Mother

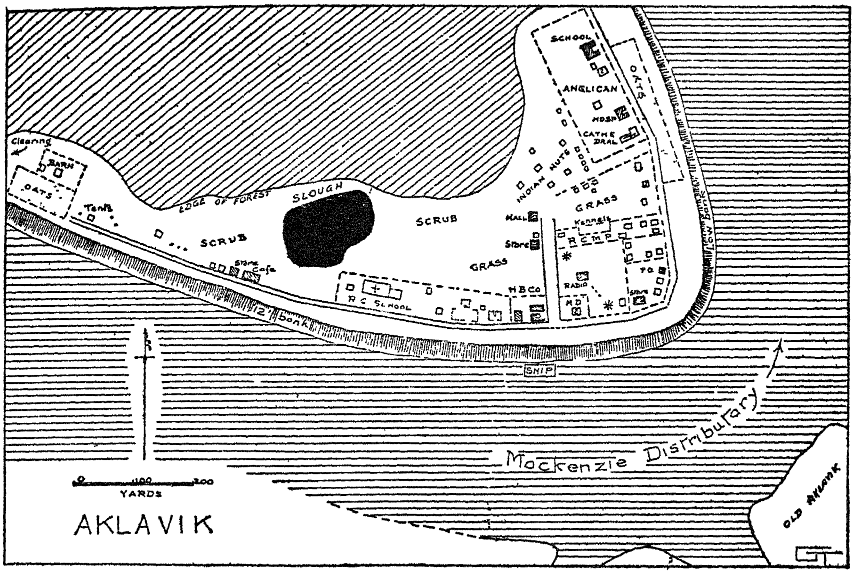


FIG. 94.—A functional plan of the settlement of Aklavik (68° 12′ N.), the main settlement on the Lower Mackenzie. Note the distinct Anglican and Catholic quarters

Hubbard dresses with a flounce often with a border of fur. The taller figures make a rather impressive appearance in this garb.

The temperatures at Aklavik are often high in July. From the 17th of July to the 27th of July in 1944 the maximum temperatures each day were as follows: 69, 75, 82, 76, 76, 57, 62, 58, 67, 65, 60. As stated, the average temperatures in Gaspé for the month are about the same (i.e. 57° F.) as at Aklavik, so that there is nothing Arctic about the climate in summer, though Aklavik is 122 miles north of the Arctic Circle. It must be remembered also that in latitude 68° N. there is over 18 hours of daylight for about four months, i.e. from 21st April to 21st August.

There is an old wooden wharf opposite the Hudson's Bay Com-

pany store at Aklavik, which suffers from ice pressure as mentioned earlier. On the low cut-bank right in the roadway a wooden scow was being built. A young calf—part of Dr. Livingstone's famous herd—was eating the grass in his private garden just back of the 'wharf'. I walked half a mile to the west along the river bank, passing the Catholic 'quarter', and reached the field of oats and the large clearing with a barn where the cows are grazed normally (Fig. 94). Since this small town is the most northerly in the British Empire, it may well be described in some detail. (See Plate IV.)

Aklavik has been built where the Peel channel comes into easy communication with the west channel of the Mackenzie, i.e. about 40 miles north of another link which we navigated much nearer Fort Macpherson (Fig. 93). Originally the post was erected in 1917 on the south bank of the distributary, here about 300 yards wide; but it was transferred to the north bank in 1920. It occupies a rounded promontory jutting to the south-east, and the main road borders the shore in the form of a crescent. Two other roads near the point join at right-angles and lead to the grassy clearing at the back of the settlement, where a dozen or more Indian shacks have been built. The little post office is at the corner, with the radio station on the west and the police station on the north. Then in the north-east quarter of the town is the large Anglican community, much the most impressive of any such groups in the whole north-west (Fig. 94). Along this part of the river front a reserve has been left about 50 yards wide. Much of this has been ploughed in 1944 and sown with oats. This will not ripen, but will be cut for cattle food in late September. Behind the large radio station there is a community hall and a large private store. There is also a smaller store on the point near the post office, and yet another with a café, between the Catholic school and the Livingstone barn. In the rear of the Catholic school is a pool or slough about 150 yards across.

Though Aklavik is not large compared with Igarka—which the Russians have built in a similar latitude on the Yenesei River—yet it has some impressive buildings. For instance, the Anglican Cathedral consists of a nave with a well-proportioned square tower at the north-east corner. It is a frame building painted light yellow, as are all the buildings in the Anglican quarter. The remarkable altar picture—about 8 feet wide—represents the Wise Men presenting gifts. The various figures in the painting, which was executed by an Australian artist, are clothed in the garb of Polar Canada.

To the south of the Cathedral is the two-storey house occupied by the clergyman, while to the north is the large two-storey hospital built with two wings projecting in front of the central portion of the building. Further to the north is another neat two-storey dwelling where the senior teacher lives. Then comes the large

boarding school of a somewhat similar style to the hospital. Here about 50 Indian children and 50 Eskimo children live a large part of the year. They go home for the summer vacation, and we carried six Eskimo children to Tuktuk within a few days. There were several white teachers at the school.

The Catholic buildings in the west of the settlement were of a similar character; but the school was larger, comprising three storeys. A portion of this building is used as a church. There is also a Catholic hospital and a large house for the priests, of whom there are half a dozen as well as a number of Sisters. The number of children in the school was about the same as in the Anglican community. Anchored in the stream was an auxiliary yacht which belonged to the Catholic Mission (Fig. 94).

From the point of future settlement the presence of a dairy herd here is of much interest.[1] The cows live in the barn until the middle of April, when they come out and graze in the vicinity. The newly cleared spruce forest seems to produce *Equisetum* (Horse-tails) mainly at first, but the older grass among the houses and behind the settlement seems much more attractive to the cattle. There is some native grass, which is cut and used as hay. Early in June the new grass is grown enough to be useful. The oats is sown at the end of June, while vegetable seeds are sown two or three weeks earlier. Lettuce and radish can be used about the 7th July. Towards the end of August frost is expected, and potatoes are dug early in September, while the grain is cut towards the end of this month. Some time in October the cattle go back to winter in the barn (Plate IV, p. 192). Dr. Livingstone distributes the milk in the usual sealed bottles, whose caps bear a printed label 'The British Polar Dairy'. (The Tundra lands and Tuktoyaktuk are discussed in the next chapter.)

NATURAL REGION 17: THE YUKON TERRITORY

Topography, Climate and Vegetation

This large region of Pioneer Land in the extreme north-west of the Dominion comprises 205,346 square miles, and so forms about 5½ per cent of the area of Canada. As the topographic map (Fig. 95) shows, it is in the zone of Young Mountains, and consists essentially of ranges running north-west to south-east, with the main river the Yukon-Lewes occupying a parallel valley across the southern half. The dotted areas in Fig. 95 show approximately the highlands above 5,000 feet, which are mainly to be found in the south-east portion of the wedge-shaped territory of the Yukon. But almost all the rest of the area is above 3,000 feet, for only relatively small patches in the valley of the Peel and Porcupine Rivers, and in the Yukon valley around Dawson, are below 3,000 feet.

[1] The dairy was abandoned in 1945.

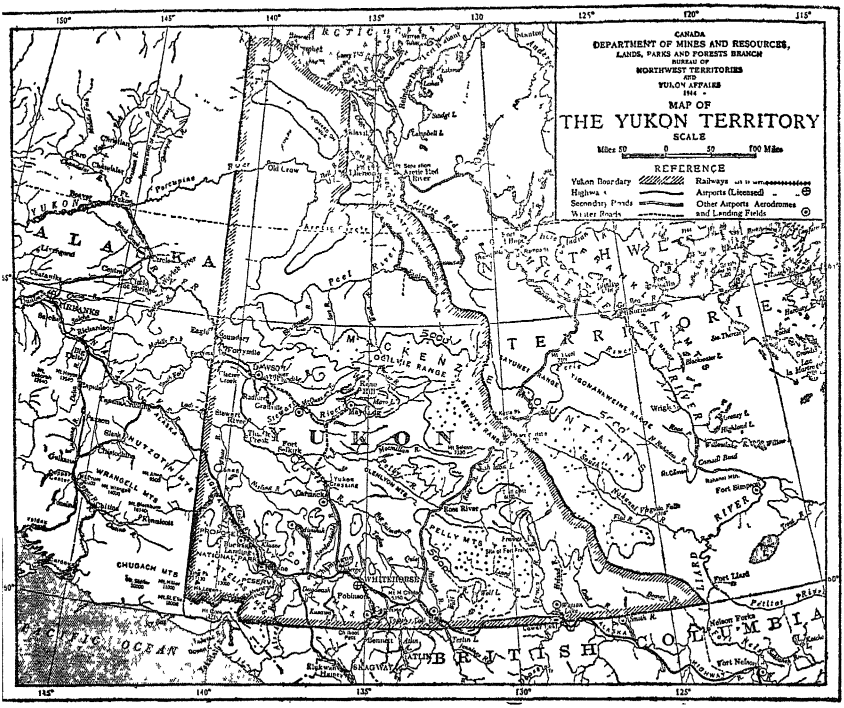


FIG. 95.—Map of the Yukon Territory and of the Lower Mackenzie. The dotted areas are above 5,000 feet. (From the Dept. of Mines and Resources). The Alaska Highway is charted

The elevated basin in the south-west corner of the Yukon is rather poorly named the 'Yukon Plateau', for it is merely a normal high-level basin with none of the real attributes of a plateau. (A plateau should stand out above the general level, and be approached up scarps, which is certainly not the case with the Yukon 'Plateau'.) The surrounding mountains rise to great heights in the south-west corner, where are to be seen the glacier-mantled slopes of Mount St. Elias and Mount Logan, which are over 18,000 feet. The main range across the centre of the Yukon is called the Mackenzie Mountains, and this rises to 8,500 feet at Keele Peak, near the Pipe-line Road. Other peaks over 8,000 feet are to be found in the vicinity of Old Fort Frances in the south-east. Dawson City on the main Yukon is one of the lowest spots and this has an elevation of just 1,200 feet above sea level. (Possibly peaks up to 10,000 feet lie at the head of the Snake River in the Ogilvie Range, but this is not certain.)

The Yukon area near the main river consists of rolling uplands,

whose summits show marked uniformity of elevation over broad expanses. According to the official account a broad warped depression in the surface of the upland occupies the central portion of the plateau.

A network of main valleys is deeply entrenched from 1,000 to 2,000 feet below the upland surface. The greatest of these north-west valleys extends north-west from the Liard, and is occupied in part by the Liard, Pelly, Stewart, Klondike and Yukon Rivers. Another great valley, the Shakwak, extends from Kusawa Lake north-west along Kluane Lake. On rare days the great peaks of the St. Elias Range can be seen from prominent elevations hundreds of miles away, dazzlingly white in their almost complete mantle of ice and snow, and appear to float like clouds above the denser hazy atmosphere below. (*Yukon*, Ottawa, 1944; from which the map is taken.)

The Yukon-Lewes River is navigable for the whole distance from Whitehorse through the Yukon Territory and Alaska to the Ocean. Within the Territory itself small steamers can navigate 1,400 miles of the great river and its tributaries. As we shall see, the climate is semi-arid, so that there are few lakes in the interior, though many beautiful examples, such as Teslin and Kluane, are to be found close to the snow-covered mountains. Owing to the small precipitation in past times, as well as present, it seems that no ice sheet covered the western lowlands of the Yukon during the Ice Ages (Fig. 95).

The general geology of this region is much like that of the southern portion of the Rocky Mountains in Canada. Most of it seems to consist of Paleozoic formations; but narrow strips of eruptives, running in the dominant direction of the ranges, occur on the line joining Dawson to Fort Frances. A similar belt runs from Kluane Lake to Skagway, and no doubt there are others not yet properly charted. Some narrow patches of Tertiary rock are found in the vicinity of Dawson, Ogilvie, and Selkirk. Some notes on the geology of the Klondike field will be found later in the book (p. 438).

The climate does not differ much from that experienced in the other inland portions of northern Canada. The range of temperature is very high in the north-east, amounting to about 80° F.; but falls off considerably to the south-west, where proximity to the Pacific brings it down to about 50° F. The mean temperatures for the year are about 25° F., and the rainfall is low—at any rate in the valleys where is the sole settlement—and does not amount to much more than a dozen inches a year. The data for Dawson City (about the middle of the area), and for Atlin (near the southern boundary) will give a clear idea of the climate.

CLIMATE OF YUKON

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Dawson, Temp.	−22	−12	4	28	46	57	59	54	42	26	1	−11	23° F.
Rain	0·8	0·7	0·5	0·6	0·9	1·2	1·5	1	1	1	1	1	12·5 in.
Atlin, Temp.	2	8	18	31	43	51	54	52	45	36	23	13	31° F.
Rain	1	0·8	0·6	0·3	0·4	0·8	1	1	1	1	1	1	10 7 in.

The winters are long and cold, but owing to the absence of high winds do not cause much discomfort. There is almost continuous daylight from mid-May to early in August, and in this period the temperatures are high enough to produce a pleasant climate for active people. The effect of the sun on the hillsides is quite marked, so that those slopes facing the noon sun are grass-covered and relatively bare of trees ; while the shaded slopes have more moisture and are well-wooded. (See J. L. Robinson, *C.G.J.*, Aug. 1945.)

Halliday has assigned a special class to the forests of the Yukon, which he states vary somewhat as between east and west (Fig. 87). In the east, glacial debris has been deposited, while in the west the soils are derived from the underlying Paleozoic rocks, &c. The best tree growth appears to be on the middle slopes, the growth being smaller on the lower slopes and in the valley proper (*Forest Classification*, 1937).

White spruce forms the bulk of the stands, mixed with aspen, balm of Gilead, and Alaska white birch. Black cottonwood (*Populus*) is found in the river valleys in the southern parts. Lodgepole pine occurs in small groves, while in the swamps are found stunted spruce and some tamarack. Near the upper limit of trees, around 4,000 feet, alpine fir becomes dominant (Halliday).

The official account of the Yukon states that merchantable timber suitable for sawlog material may be found in the lower parts of the valleys east of the Lewes and Yukon Rivers as far north as latitude 65°. The timber line ranges from 5,000 feet in the south to 4,000 feet near latitude 65° N. ; but the belt for 1,500 feet below the timber-line contains only poor timber, not suited for sawlogs. White spruce is the most valuable of these timbers, but much of it in the Yukon valley was cut out for mine material in the days of the great gold rush (1897–1906). Poplar and birch grow in upper levels of the valleys, but not to great size. They are, however, useful as fuel (Fig. 87). Wood has been burned as fuel on the river steamers for nearly fifty years, and a supply of 150 cords is needed for the round trip Whitehorse to Dawson and back, a voyage of about nine days. There are a number of sawmills in the Territory, i.e. at Mayo, Dawson, and along the Alaska Highway, and this timber is used

for houses and small boats. The larger steamers on the Yukon have been constructed with imported timber.

The Yukon Basin from Whitehorse to Dawson City

Early in August 1944 the writer made a journey from Whitehorse by steamer to Dawson, returning by air over Mayo and the Macmillan Mountains.[1] Since this is by far the most important portion of the Yukon, a fairly full account will make the reader acquainted with the general environment of this distant corner of the Dominion (Fig. 95).

Whitehorse has a position on the Yukon-Lewes river which is analogous to that of Fort Smith, i.e. it is at the south end of the navigable portion of a huge river; and hence a town has inevitably grown up at this site. The Whitehorse Rapids lie about a mile above the town, and were not a complete obstacle to traffic, since in the early days many scows and rafts floated down them, *en route* to the Klondike goldfield. The first settlement was made by the fur-trader Campbell at Selkirk in 1848, about half-way between Whitehorse and Dawson. The first buildings at Whitehorse consisted of a telegraph office and hotel built in 1898. In the same year a small steamer was built on Lake Bennett (south of Whitehorse), and successfully reached Dawson. The famous White Pass Railway reached Whitehorse in 1900, and saved the difficult journey over hills, down rivers and across lakes, which was necessary before that date. Three major events in Whitehorse have developed in recent years. A great airport has been built on the upper bench, 200 feet above the town; the Alaska Highway has just been completed, and passes close to Whitehorse on the west; and lastly the 600 mile pipeline and road has recently reached the large Refinery from the oil wells at Norman Wells (Fig. 95).

The town is built, according to the usual grid pattern, on the flat bench about 15 feet above the Lewes River. The normal population is about 500, but the influx of Americans and other folk connected with the new developments mentioned above has swelled the figure to some 8,000. These folk (soldiers and others) are accommodated in wooden barracks on the margins of the town proper. Along the main street, which runs at right-angles to the railway and river, are two large hotels, two cinemas, and a dozen or so shops. Along First Street are two department stores, the post office, and a large hospital. Here also are the Government quarters, with police, radio, telegraphs, &c. Schools and churches are found in the margins of the town.

[1] See 'Yukon Domesday, 1944', by the author, in *Canad. Jnl. Economics*, Toronto, July 1945. In 1956 Whitehorse held 2,500 people.

We left by the stern-wheel steamer on the evening of August 3rd for the Klondike goldfield. The scenery along the river is often most picturesque, and very different from that along the Mackenzie. About 16 miles north of the town we entered Lake Laberge, some 30 miles long and 3 miles wide. Along the banks of the river farther north were regular terraces at various levels, like those so characteristic of the British Columbia rivers. At Carmacks the adits of several small coalmines were visible in the banks of the river. There are less than 20 folk now living at this settlement.

The most scenic spot on the river is found at the Five Finger Rapids, which are about 16 miles below Carmacks. Here the Lewes River is barred by a wall of conglomerate 20–30 feet high, in which five narrow channels have been cut by the rapid waters. Only one of them is wide enough and deep enough for the steamer to pass through ; and since the current is very swift here, the whole traverse is a matter of a minute or two. On the return the steamer at times literally winds its way upstream along a chain fastened to the shore. A few miles lower down, the good road from Whitehorse ends, but a winter road proceeds north to Mayo and Dawson (Fig. 95). At Fort Selkirk are two large stores, two missions with their churches, telegraph and police stations. But the whole white population of this oldest post in the Yukon is under a dozen. Here the Pelly enters from the east, and to the north the river is known as the Yukon. Near Coffee Creek and Thistle Creek are small settlements with beautiful gardens, growing fuchsias and geraniums at the latter place. Delphiniums 5 feet high are common in the bush —an unexpected sight in latitude 63° N. We reached Dawson late in the evening of August 5th.

Dawson City and the Klondike Goldfield

Dawson is built on a flat about 20 feet above the Yukon at a height above sea level of 1,200 feet (Fig. 96). Mountains 2,000 feet higher rise close to the river on most sides, and very marked elevated river terraces occur in many of the valleys. These terraces have been sluiced for their gold contents in the Klondike valley, which enters the Yukon valley just to the south-east of Dawson. A ferry, swung on an elevated steel cable, crosses the Yukon at Dawson, being driven by the force of the river current acting on the broad rudder.

The most famous valley in the world for alluvial gold lies just to the south of Dawson, and is called Bonanza Creek. Its main tributary, about 9 miles south of Dawson, is Eldorado Creek, which rises in the granite mass of the Dome (4,250 feet, sketched in Fig. 138). Hunker Creek and a few valleys south of the Dome were also found to contain much alluvial gold. No veins, from which this alluvial

was derived, have been found on the Dome, so that probably the original gold veins have been removed by erosion.

The boom time was around 1900, when there were about 20,000 people in the Klondike diggings. Today there are practically no diggers, and the goldmining consists exclusively in dredging by means of a dozen of the largest dredges known. These are slowly working over the acres of tailings which remain in the valleys as the result of the labours of the previous miners.

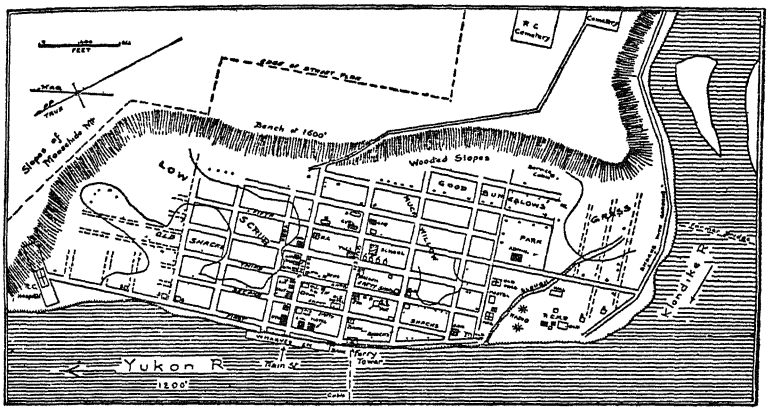


FIG. 96.—A plan of Dawson City, capital of the Yukon. The Klondike goldfield is a few miles to the south.

Dawson City, although it is the capital of the Yukon, is a town whose best days have long passed away. It is still active ; yet the streets of empty shops and the numerous abandoned cabins recall the more flourishing days of the Klondike boom. I made a detailed functional plan in order to find how the town had changed during the last forty years, and the chief features are charted in Fig. 96. The plan of the town is the conventional grid, with the main street running at right-angles to the river, and crossing First, Second, Third, &c., streets as one proceeds east to the high terrace. Originally streets were surveyed on the terrace, but few houses ever climbed the 300-foot scarp, though the cemeteries are on the terrace (Fig. 96).

There are several warehouses and large wharves and an imposing bank along the river in First Street. Here also is a fine department store, a cinema, and the chief hotel. The dozen chief shops are in the main (King) Street ; some of them being built of brick, which is most unusual in the far north. The decay of the town is most obvious in Second and Third Streets, where most of the shops have been boarded up for the last thirty years, and where there are

four abandoned hotels. There is a large Administration Building for the Yukon about a mile to the south-east of the main wharf, and this now houses the post office; and the large post office in King Street is no longer used. At the junction of the Yukon and Klondike Rivers is the huge building of the Royal Canadian Mounted Police, but this also is empty; and the small detachment of police lives in a wooden building alongside. The Presbyterian Church nearby is no longer in use, though the Anglican Church survives. A large Catholic Church ornaments the main street near the fine large school. This latter has four teachers and about 130 pupils. A masonic hall, theatre hall, and rink, are half a mile east of the wharf (Fig. 96). In 1950 Dawson had a population of 1,043.

The better residences take the form of pretty little bungalows, and they are built on the slopes behind the Administration Building, overlooking the grassy park in which the latter is situated. There are many rather dilapidated shacks on the edges of the town, especially to the north. Here they are shrouded in the growth of willows, which are covering much of the street grid on the margins. In the middle of summer some of the gardens around the better houses rival many of those of Toronto in the beauty and size of their flowers. One large firm in Dawson has extensive greenhouses, in which tomatoes are grown and exported to the large population at White-horse. Celery was growing out in the open during my visit (though started under cover), and all ordinary vegetables such as cabbages and beans grow splendidly in this area. A large dairy herd is grazed on many acres of grass near the airport, and milk is regularly delivered from this herd. Much Brome Grass has been planted in the native meadows, and wheat has been grown and ripened at Swede Creek, a few miles out of Dawson.

Some notes of a journey made along the Klondike, Bonanza, and Eldorado valleys in August 1944 will indicate the vast changes since the Klondike Gold Rush of forty years ago. There is a fair if rough road to the head of Eldorado, which is feasible for motors if they do not travel quickly (Fig. 138). In places it has been washed away to reach the gold in the gravels beneath, but the Dredging Company has built an alternate road here. One or two little villages of 30 men were seen, where the dredge outfits lived. There were stables here, since horses are found useful for many purposes around the dredges. I saw one prospector on the whole journey, who was washing the gravel in a primitive sluice box. At Grand Forks there used to be two churches, a school and several thousand miners, but today there were about six houses and a dozen settlers at most. It was surprising that there was practically no trace of diggings or huts anywhere in the valley. Second growth of poplar, &c., tended to hide the shallow diggings, while the cabins had been carted elsewhere, or burnt in the

long interval since the rush. There was a little hydraulicking in one terrace, where a jet of water was tearing down the gravels, and washing it into sluices. But the war has blocked goldmining for the time in Yukon, as elsewhere.

The flight from Dawson to Mayo and Whitehorse was by far the most interesting of the half-dozen flights I made in the north (Fig. 95). In the first 110 miles we crossed the Klondike and McQuesten valleys and their tributaries. The landscape consisted of rolling plateaux, in which rather broad flat-floored valleys were carved by present streams and past ice. Green sloughs were often present on these plateaux, and in some places there were definite scarps to the flat uplands. Some of the valleys seemed to be over-deepened by ice, and the present streams were misfits, meandering about on the flattish floors.

After leaving Mayo we flew among the Macmillan Mountains which rise over 7,000 feet. There were patches of snow near the summits of these mountains, and small cirques pitted the sides of the higher ranges. We flew just to the east of Lake Tatlmain, and crossed over a residual plateau, with steep valleys notching its margin, just before we reached Lewes River. We flew along Lake Laberge, and reached Whitehorse about three hours after we had left Dawson City. This journey upstream in the steamer usually takes about five days.

Mining is of course the chief primary industry in the Yukon, and dates back to the first prospecting in 1872. For twenty years a good deal of gold was won in the main valleys, and then it was found that coarser gold occurred in the side valleys. In 1892 the placer (i.e. alluvial) field of Sixty Mile was discovered; and some years before the Klondike Rush started, this older field produced $225,000 annually. Klondike placer creeks were discovered in 1896, and when thousands of miners spread over the Yukon, as occurred in the next ten years, many other mines were discovered. The other chief fields are the Whitehorse copper-mines, some few miles west of the town; the Mayo silver-lead district; and the Carmacks coal basin, already briefly described. Tungsten and tin in small but workable deposits have also been found. In 1942 the gold production of the Yukon was worth over 3 million dollars, and silver-lead about a quarter of a million. (In 1947 gold won was worth 1·6 million dollars.)

NATURAL REGION 18: NORTHERN BRITISH COLUMBIA

This region includes all of British Columbia north of the Canadian National Railway from Yellowhead Pass to Prince Rupert. The country near the railway has been briefly described on p. 199, and the map in Fig. 65 shows that there are no real roads north of this railway, only trails to outlying mines and isolated settlements. The

region has probably less than a thousand inhabitants, if we exclude the miners near Stewart; and consists of the basins of the Dease, Taku, Stikine, upper Skeena and Parsnip Rivers (see Endpaper Map).

The topography has already been briefly described on p. 170; and consists of an elevated basin between the Coastal Ranges and the Rockies, whose general level is about 3,000 feet above sea level. In this basin the rivers have cut narrow gorges in places, and elsewhere glaciers have carved out wide flat-floored troughs, much as we have seen in central British Columbia. The most interesting feature is of course the Rocky Mountain Trench, which is seen in its most striking section in this region. For almost 300 miles this valley borders the Rockies, and is drained by the Kechika flowing north from Sifton Pass, and by the Finlay flowing south from the same point to meet the Parsnip River, which continues the great trough at Finlay Forks.

We owe to G. S. Andrews an account of the topography of this area, which is published in the *Geographical Journal* for July 1942, and contains some very illuminating air photos of the great trench. He was engaged in a survey to find the best surface route to Alaska, and he puts forward reasons why this route west of the Rockies should be chosen, rather than the Alaska Highway, which was later constructed and runs east of the Rockies until Teslin Lake is reached. The 'Trench Project', as we may term that surveyed by Andrews, would have crossed the Alaska Highway at Watson Lake, after which it proceeded to the north-west past Frances Lake and down the Pelly River to Dawson City.

The floor of the Trench in the present region is from 5 to 15 miles in width, and the highest point is called Sifton Pass at the head of the Finlay River, which is 3,270 feet above sea level. As one of the air photos shows clearly, this pass is a typical 'valley divide', and does not involve any difficulty in reaching the headwaters of the Kechika. This route is therefore easy for construction, and there is a lighter snowfall than any route still farther west. Andrews points out that for 400 miles the route follows the line of contact between the Rocky Mountain sedimentaries of the east and the eruptives of the great Omineca batholith (granite mass) to the west with its great mineral possibilities. Aerodromes can easily be constructed along the broad flat floor of the Trench.

In 1929–30 this part of Canada was first surveyed from the air by photography, and more detailed studies of the Trench were carried out by Andrews and his party in 1939–41. The surveyors received most of their supplies from the *south via* Prince George, but two parties used the northern line of transport, *via* Wrangell at the mouth of the Stikine River. Here a stern-wheeler takes the cargo for 140

miles up the river to Telegraph Creek, then a rough wagon road leads to Dease Lake. From here the goods are carried 130 miles by boat down the Dease River to Lower Post near Watson Lake (Fig. 95).

In this part of the Dominion the continental divide does not run along the peaks of the Rockies, but is far to west, along the summits of the Cassiar–Omineca mountain system. The core of this mass of rocks is granitic, and it is probably a batholith akin to that forming the Coast range (Fig. 61). Thus there are good chances of valuable minerals being found in these mountains, and indeed a number of mines have long been worked.

In the 'axe-head' corner of north-west British Columbia there are many small mines in or near the Tatshenshini Valley. Here gold, copper, silver, lead, and zinc have been worked in the last thirty years.[1] At Atlin and Taku (on Atlin Lake in this corner of the Province) large mineral deposits, mostly of placer gold, have been worked for many years. The field is reached by the Skagway Railway to Carcross; then by lake, rail, and lake to Atlin. The alluvial can only be worked for a few warmer months of the year, which handicaps the miners greatly. Copper, antimony and tungsten are found in the vicinity.

In the Cassiar Mountains near Dease Lake are outcrops of the Omineca batholith, and these are reached by boat up the Stikine River. Some 4 million dollars' worth of gold were won way back in the 'seventies in this area, and in 1924 new finds of gold were made in the region. A crushing-mill has been erected at McDame on Dease River, while platinum is found in placers in the vicinity. For many years the chief producer of gold in the province was the Premier Mine at the head of the Portland Canal, just on the boundary of Alaska. In 1925 this mine produced 118,000 ounces of gold, over 2 million ounces of silver, and 785,000 pounds of lead. About 60 miles south of the Premier Mine is Anyox, for a time one of the leading producers of copper in the Dominion. A good deal of silver and gold also comes from this mining field.

The Alaska Highway from Whitehorse to Dawson Creek

The writer made a rapid traverse of this route during August 1944, and a brief description will enable the reader to judge of the possibilities other than mining in the north of British Columbia. Almost the whole of the 900-mile route (except near Whitehorse) lies within the province with which we are concerned; and all of it is typical of the plateau-like expanses which form the summits of the northern Rocky Mountains. This route was chosen to con-

[1] L. O. Thomas, 'Mineral Possibilities', *Canad. Mining Bulletin*, Montreal, 1943.

nect a chain of recently built aerodromes along the Alaska air route, through Edmonton, Fort St. John, Fort Nelson, Watson Lake, and Whitehorse (Fig. 95). Andrews (*loc. cit.*) points out that the distance from Edmonton to Watson Lake is 15 per cent greater *via* Fort Nelson than *via* Prince George and the Trench. The dangers from floods and from swampy terrain are much greater in the eastern route, but it was favoured by the American authorities who built the road.

The Americans wished to have a safe military route if the Japanese Navy should be able to block traffic by sea along the coast to Alaska. They also realized that, in these days of air travel, the natural line of air attack from Asia would be by way of Alaska; and so a military road was built in 1942–3 almost regardless of cost. It was constructed in eight months from March to October in 1942. Between March 7th and December 28th of 1942 more than 7,500 carloads of freight were transported by rail to Dawson Creek for construction purposes (Fig. 81). At times the engineers built as much as 8 miles of road in one day. By November of 1943 the gravelling of the road was nearly complete, though it had been in use for many months. Some of the larger permanent bridges were not yet quite in order when the writer used the road nearly a year later. No one could travel on it without a military permit. (It is now, 1949, open for all traffic.)

We left Whitehorse in a large Greyhound bus holding about 30 passengers at 8.30 p.m.[1] Two drivers are on each bus, and the journey goes on day and night at about 30 miles an hour. The surface is almost perfect, wide and well cambered, with a 20-foot clearing at each side of the road. About 10 miles from Whitehorse we were stopped by a military guard so that all passengers and papers could be checked. Alongside the road lay the 4-inch iron pipe which carries the oil from Norman Wells to Whitehorse, but this branched to the east near Teslin Lake (Fig. 95). Meals are taken at the maintenance stations, which are provided by the Administration at regular intervals along the road.

Very early next morning we were approaching the continental divide, at a pass where the headwaters of the Teslin River approach those of the Liard. The road reaches a height of 3,400 feet here. We were traversing an undulating plateau-like country, with rounded summits rising to five or six thousand feet close at hand. About a mile to the south several cirques could be seen on the sides of the highest knob. Hereabouts the tree-line seemed to be about 5,000 feet, but at 3,000 feet—the level of the road for many miles—there was a cover of spruce and poplar, with stems about 7 inches in diameter. As we dropped down to the Liard River, the trunks

[1] Several maps illustrating the topography on this journey accompany the description of the 'Alaska Highway' in my article in *Canad. Jnl. Economics*, Toronto, July 1945.

increased to as much as 18 inches in some of the spruce. Near Watson Lake (Lower Post) a good deal of lodgepole pine mingled with the spruce (Fig. 95).

Hereabouts we crossed the Rocky Mountain Trench, and at the Hylands River saw almost the sole 'settler' at a new Hudson's Bay store. Here the road runs fairly close to the Liard River on its north bank until we reached the interesting 'Hot Springs'. Here most of the passengers indulged in a bath, in water near boiling-point where it emerges from the ground. The road here crosses the big river to the south, and then enters mountainous country near Muncho Lake, which is an alpine lake about 3,000 feet above sea level (Fig. 87).

To the north of Lake Muncho appeared a veritable Matterhorn rising to 8,000 feet, while a row of pyramid mountains fringed the road for many miles. We traversed a regular canyon on our approach to Racing River, and then ascended to the highest point of the road (4,200 feet) just before a long descent to Fort Nelson. At Steamboat Creek was a small sawmill, and here the spruce and black poplar was much larger than we had seen before (Fig. 81).

Fort Nelson lies a good way off the direct line to Dawson Creek (Fig. 81A), and so we turned south from this settlement; and after 50 miles once more climbed to the 4,000 foot plateau, an outlier of the main Rocky Mountain massif. For some 50 miles the road is built at this high level, but early next morning we dropped down to the plains near Fort St. John. About 5 miles from this town we saw the first farms on the whole 900-mile journey. (Dawson Creek settlement is described on p. 231.)

CHAPTER XII

THE TUNDRA LANDS

NATURAL REGION 19: KEEWATIN AND ADJACENT TUNDRA

THIS chapter deals with a portion of the Dominion where there are no probabilities of close settlement, save perhaps in some mining district yet to be discovered. The region lies between the great belt of Coniferous forests, which has already been discussed, and the great Ice-Cap of Greenland (Fig. 99). It can readily be divided into two parts: the tundra on the mainland and the Arctic Archipelago. The former comprises the region of Keewatin, which is the portion of the Dominion to the east of the Great Lakes (Bear and Slave); as well as the northern part of the province of Quebec to the west of Ungava Bay, which we may call 'Ungava'.

The Tundra Port of Tuktoyaktuk

In the summer of 1944 the writer spent some weeks north of the Arctic Circle at the mouth of the Mackenzie River. Since this is the farthest north point to which the Taiga of Canada reaches, some account of the way in which it changes to the Tundra environment should be of interest. The main settlement of the north is Aklavik, in the middle of the great Mackenzie Delta (Fig. 93). Here spruce trees almost 2 feet in diameter can be observed, and there is no indication that Aklavik is 120 miles north of the Arctic Circle (p. 266). The shift from river traffic to ocean traffic in the delta results in some interesting problems. On the Mackenzie the boats cannot count on more than 4 feet depth of water in a number of places, so that all the boats are flat-bottomed and driven by a stern-wheel. On the ocean such boats with their three decks are completely at the mercy of any wind, and will drift ashore unless any *open* portion of the waters is traversed in dead calm. The ocean schooners and small ships have of course much more draught, and hence do not find it easy to reach far up the Mackenzie. Thus some intermediate port is necessary, and at present Tuktoyaktuk is the favoured place.

Our stern-wheeler the *Distributor* (800 tons) left Aklavik about midnight, and after winding through cross-channels and the broader main eastern channel we were off the Reindeer Depot about 4 p.m. of July 19th. Here is the headquarters for the new reindeer industry, which has recently started in Northwest Territories. In the hilly country back of the depot graze some 5,000 deer, who were brought from Alaska during a long migration covering about five years,

which ended in March 1935. The animals are grazed in Tundra country; on Richards Island at the mouth of the Mackenzie in the summer, and on the open mainland Tundra in the fall and winter. Eskimo youths are being trained to look after the herds.

The Reindeer Depot is prettily situated below a cleft in the range called the Caribou Hills, which rise about 500 feet above the delta. The upper portions of these hills were bare, though spruce still grew fairly thickly in the gullies. There are about a dozen houses in the depot, including several two-storey, painted residences. Plenty of trees have been left around the settlement; and it seemed a better site for the 'metropolis' of the delta than Aklavik, though I had no time to go ashore to make a survey. This region is all part of a large Game Reserve, and the captain had to receive a permit before we could proceed down the Mackenzie.

Some 10 miles north of Reindeer Depot there is a great change in the environment (Fig. 93). The spruce forest ends relatively abruptly, and as Richards Island came into view we saw the last clumps of spruce left behind. The low muddy islands in the channel were, however, often clothed in dwarf willow, cotton grass, &c., though the broad mudbanks showed that some of the land had only recently been formed.

Next morning we were in the Arctic Ocean east of Richards Island. Along the shore to the east were numerous mounds like small volcanoes, apparently about 100 feet high. These are the 'Pingoes' of the Eskimos, whose origin is not properly understood. Stefansson gives a good photograph of one in his book *My Life with the Eskimo*. They seem to be due to the final freezing of the centre of a lake of *muddy silt*, like the 'apple-pies' of the Antarctic, but have not been investigated by a geologist as far as I know.[1] The boat was held up near Kittigazuit the whole of the 20th and 21st of July waiting for a perfect calm, so that we could traverse the 20 miles of open ocean which separated us from the sheltered port of Tuktuk. We reached the latter at 9.30 a.m. on July 22nd.

The topography of this northern section, i.e. Richards Island and all to the east is very different from the normal delta landscape seen south of that point. In place of anastomosing channels and low flat muddy shores, we find a much more undulating surface, often rising in rounded ridges and knolls to heights of 50 feet or more (Fig. 97). These are very clearly shown on the new charts recently issued dealing with this region. The whole country inland from Tuktuk is covered with small lakes, so that in a traverse of 30 miles there will be about 15 small circular lakes, each from 1 to 2 miles across.

[1] See 'Earth Mounds in Arctic America', A. E. Porsild, *Geog. Review*, January 1938. See Fig. 115 in the author's *Physiography of Macmurdo Sound*, London, 1922.

On Richards Island the same topography is present, and there is no doubt that this is the result of the deposition of glacial till, &c., and that the true delta muds are found mostly to the west of Richards Island. This undulating lakeland is the country in which the reindeer are grazing, and it seems to suit them well.

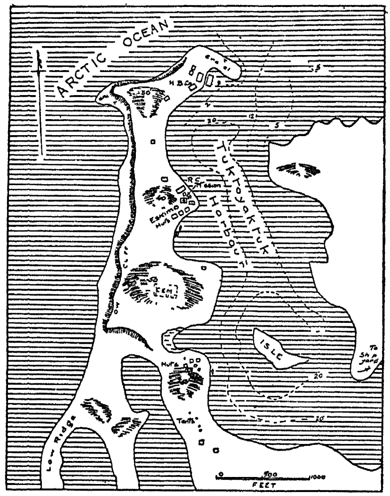


FIG. 97.—A sketch survey of Tuktuk (Tuktoyaktuk or Port Brabant), a new settlement on the Arctic Ocean in 69° 30′ N. latitude

Tuktoyaktuk (usually called 'Tuktuk' or 'Tuk') is officially named 'Port Brabant', but I never heard anyone use the latter name. It has only been opened as a port for a few years, and this was the second occasion when the *Distributor* had called there. The sea has drowned many of the small depressions, giving rise to the much embayed coasts seen near Tuktuk in Fig. 93. Indeed, the harbour at this port is but the protection afforded by a cluster of glacial hillocks, which are grouped into several islands and promontories as appears in the chart. My map is based on a pace and compass survey, checked by the naval chart which has only recently been completed for this area.

A long narrow promontory runs almost due north for about a mile, and shuts off a similar-shaped elongated harbour to the east, between the promontory and an island also marked by the characteristic hillocks. There is about 12 feet of water at the narrow mouth of the harbour, which deepens to 20 feet to the south. There are really two settlements at Tuktuk, for a small ship-repair yard has been developed about 2 miles to the south-east of the main settlement, and here several small ocean steamers were drawn up on shore for needed repairs. At this shipyard there was a small stream,

from which the settlers at the mouth of the harbour received their water-supply by boat as needed. This is obviously a considerable disadvantage to the future of Tuktuk.

There is, of course, no resemblance between this hillock and lake topography, and the flat cut-banks and river terraces on which the settlements on the Mackenzie River have been built. The hillocks near Tuktuk are about 50 feet high, and seem to be regularly arranged about 1,000 feet apart; but this may be a local characteristic, since I did not see much of the rest of the country hereabouts.

There was considerable evidence of ocean erosion in the form of gravel-spits at the west side of the entrance, and again at the 'heel' of the foot-shaped promontory (Fig. 97). Moreover, the exposed western coast was cut into a continuous cliff about 15 or 20 feet high, where the waves in storms had eaten into the promontory. The whole surface is covered with a close tundra vegetation, in which very little moss or lichen is present. Dwarf willows are abundant up to 3 feet high in the gullies. Some dwarf birch about 6 inches high was also common. Large patches of flowering lupin were abundant, a sort of shasta daisy, betony, and smaller patches of buttercups, shin-leaf and a few dryas. Primulas, fireweed, Labrador tea and cranberries, together with many sedges and grasses made up the rest of the cover. Near the 'heel' of the promontory were beds of peat about 4 feet thick, exposed in the low cliff mentioned previously. This peat was in an early stage, and had made little progress towards lignite.

The new Hudson's Bay Co. store is a neat building, as usual with a residence and several sheds surrounding it. The manager is accompanied by his wife and daughter, and apart from two Catholic priests these are the sole white residents. There is no church building, but an interesting enclosed altar can be unveiled in the main room of the French Mission House, and the room then serves as a small chapel.

There are about a dozen Eskimo families living at Tuktuk, some in huts near the mission, others about half a mile to the south. A dozen or so tents accommodated some of the Eskimos. A number of small sailing boats with auxiliary engines were drawn up on the beaches of the little bays. These belong to the Eskimos, who go out catching the small white whales, seals, and fish in the ocean to the north. In summer there is, of course, no vestige of snow or ice on the land, but it was interesting for the writer to see again the 'ice blink' far to the north, which had been so familiar a sight in the Antarctic. This blink is a sort of silvery glare in the sky due to reflection from the pack ice, and it indicated that the frozen sea was only about 30 miles away.

In addition to the Eskimo huts, some of which contained several

rooms, there were a number of tents, especially near the 'toe' and 'heel' of the promontory. The sledge dogs were tethered near these tents, and several of the high-framed sledges were lying near. Racks for drying fish or the flesh of the white whale were much in evidence. Skins of the latter were pegged on the ground to dry. Several Eskimo graves were visited just west of the European cemetery on the hill. They consisted merely of a shallow hole in which the body was laid, and then covered with driftwood (Fig. 97).

One of the most interesting features was a little garden maintained by the manager's wife, even though the latitude was 69° 27′ N. In one small patch of cultivation she had radishes growing, but only 1 inch high since it had been a cold spring. However, she expected them to mature before frosts came. She also counts on lettuce and spinach, and has raised a cabbage or two. The ground is, of course, permanently frozen about 12 inches down. In Siberia the northern margin of crops is placed at Potavpo in latitude 68° 30′ N., about the same as Aklavik, so that there was not much hope of vegetables at Tuktoyaktuk, some 70 miles farther to the north, though this is of course the warmest portion of the Tundra.

The Keewatin Region

A good survey of this region is available, written by G. H. Blanchet and entitled *Keewatin and North-Eastern Mackenzie* (Ottawa, 1930); from which many of the following data are derived. The Tundra lands to the east of the Mackenzie basin are known locally as the 'Barren Lands' or the 'Arctic Prairies'. They are said to comprise about 400,000 square miles, and apart from some hunting for fur and caribou flesh, have so far not given evidence of much economic value.

As one proceeds inland from Hudson Bay there is a gradual change from a coastal plain which has recently emerged from the sea, to an interior plateau across which the ice-sheet of glacial times forced its way and scraped off the soil and softer rocks. River valleys scarcely exist, but drainage gathers into depressions as lakes, and discharges in turbulent streams. The uniform glacial debris is broken in places by island-like areas of bare rocky country, and by hills of glacial origin, moraines, eskers, and drumlins. The plateau containing the larger lakes has an elevation of about 1,300 feet above sea level.

J. B. Tyrrell has shown that the local ice sheet moved out from a centre near Dubawnt Lake in a centrifugal fashion. The lakes and rivers do not seem to be much affected by the direction of movement, except perhaps in the case of the upper Dubawnt River (Fig. 84). The rocks all belong to the ancient formations of the Canadian Shield, and consist mostly of grey granites and gneisses. However,

in the area between Maguse Lake and Chesterfield, there are lavas and quartzites. In these latter along the coast gold deposits of value have been worked near Tavane, and some nickel ores have been found north of Rankin Inlet. In places inland there is much sandstone, which erodes to form sands in large quantity. These are carried down the Thelon River, and have partially blocked Aberdeen Lake.

Blanchet describes the Dubawnt and Kazan Rivers as little more than strings of very irregular lakes which discharge tumultuously through their rocky barriers. Sea-going boats can sail up Chesterfield Inlet and its extension Baker Lake for 200 miles. Tidal action, however, only reaches to the eastern end of Baker Lake. North of Chesterfield the country rises to 1,000 feet, and is rocky and broken. Much of the north coast between Back River and Bathurst Inlet is of a rugged nature, and rises in places to 1,500 feet.

In general in a large part of inland Keewatin, the upland soils are coarse and are marked by many boulders; while in the lower areas, where fluvio-glacial sorting has occurred, the soils are finer and much more suitable for plant growth. The vegetation carries its seed through the winter, and drops it in the early summer on the moist thawed surface, warmed by the almost continuous daylight. The aspect of the country changes from brown to green in the space of a few days, but early in August the summer green is changed to the brown of ripened vegetation (Blanchet).

Although certain hardy types of vegetation grow in the open plains, the country has no value from the point of view of croplands. Cereals will not mature, and vegetables can only be grown under very favourable circumstances. Formerly many musk oxen lived here, and there seems little doubt that vast herds of caribou still rove these tundras. It is logical to suppose that the future will see a considerable development in the rearing of domesticated reindeer; but it must not be forgotten that a pastoral occupation of this kind will add little to the density of the human population.

The western shores of Hudson Bay have been somewhat difficult to survey accurately, owing to the very shallow seas, and to the rough ice which accumulates on the low shores (Fig. 84). For instance, Rankin Inlet was shown on early maps as extending 60 miles inland, whereas in truth this inlet is but 20 miles deep. Long, narrow, and winding islands and points occur, which are probably 'eskers' laid down under the ice-cap. Good harbours for ships are scarce and shelter is almost lacking. Chesterfield is situated on a wide bay completely exposed to gales from the east. Marble Island (formed of white quartzite) offers fair shelter, but is surrounded by dangerous reefs. Term Point was formerly much used by whalers as winter-quarters. Tavane has a well-sheltered harbour, and is approached

by a deep channel. Sentry Island off Eskimo Point is an 'esker', and at present large boats lie off the shore and goods are brought ashore in lighters. Fullerton has a good harbour, but with a difficult approach.

The climate of this part of the Dominion can be appreciated from a reference to the following table, where the temperatures for Chesterfield are given, and contrasted with those of Fort Simpson on about the same latitude, but inland.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Chesterfield	−27	−26	−17	1	21	37	48	46	38	24	0	−17	11° F.
Ft. Simpson	−17	−10	−2	21	40	52	60	56	46	32	8	−10	23° F.

This table shows us clearly the great advantage of a 'continental' as opposed to a 'marine' climate in high latitudes. No trees will grow at Chesterfield, while Simpson is 600 miles south of the limit of trees. The rainfall along the Hudson Bay coast is low, amounting to 11 or 12 inches in the year in the north, but at Churchill it has risen to 17 inches. The rainfall is fairly well distributed from June to September, the maximum occurring in August, as is usual in snow-bound countries.

Blanchet describes the general weather as follows: The outstanding feature is the long mild spring, with a great deal of cloudy weather; a short summer of rapid growth and fine weather; a long mild fall, misty at first then bright and cold; and a cold winter with clear skies, broken by occasional high winds with drifting snow. It is unusual to have enough snow to travel until late December. Towards the end of April the sun has sufficient heat to soften the surface of the snow, and 24th May may be taken as the last date for land-travel by sleighs at Eskimo Point. Baker Lake is open for navigation until about mid-October. The sea-ice in the bay is about 18 inches thick by the end of November, and reaches a thickness of 68 inches by the end of April.

Southampton Island and the Ungava Region

Although the Arctic mainland of northern Quebec, formerly the district of Ungava, is under provincial administration, its Eskimo population is controlled by the North-West Territories Administration. A useful study of this area has recently appeared by J. Lewis Robinson, i.e. the 'Eastern Arctic' (Ottawa, 1944), and this has been used for much of the following account.

Southampton Island is about 200 miles wide and exhibits two different types of landscape (Fig. 98). Most of it, excluding the north-east coast, is low, flat, limestone country. Sloping terraces, which mark ancient beach lines, are the chief topographic features.

But along the north-east coast are rather rugged hills of Pre-Cambrian age, which rise about 1,000 feet above the plains to the south-east. According to T. H. Manning, who has given a recent account of the island,[1] the lower portions are divided into numerous plateaux, and these are buried to the depth of 3–6 feet in fragments of limestone, resulting from the breaking down by frost of the rock below. The highest mountain reaches 1,750 feet on the north-east coast which is marked by steep cliffs rising 1,000 feet from the sea. In this portion of the island there are many short rivers with canyon-like valleys; but at the mouth of Boas River (Fig. 98) the tide goes out 3 or 4 miles, 'leaving mud in which one sinks to the knees'. This river winds through a maze of lakes, and is about a mile wide at the mouth, but it is very shallow except in the spring floods.

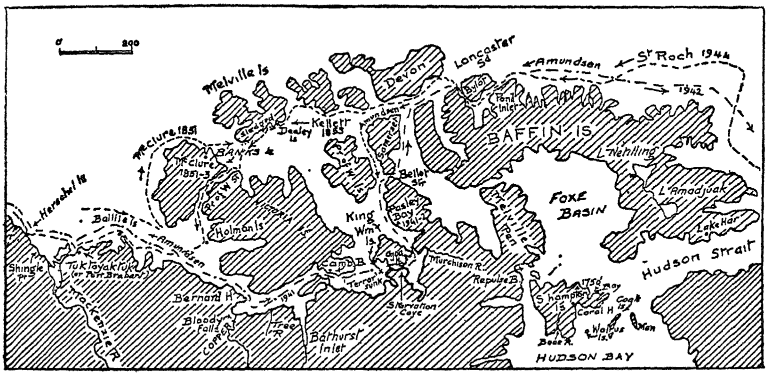


FIG. 98.—The northern coast of Canada and the adjacent archipelago; showing the voyages which conquered the North-West Passage in 1851, 1904–5, 1942, and 1944. A large island has been sighted in Foxe Basin

Manning reports that there are about 120 Eskimos living on the island, in small groups along the south coast. There is a Hudson's Bay store at Coral Harbour (Fig. 98), near which are the great majority of the Eskimos today. Manning makes some interesting remarks on the half-breeds. 'There is no doubt that this mixture of white blood has improved the stock. It does not appear in any way to have lowered their resistance to the climate, while it has increased their enterprise. The half-breed considers himself superior to both white and Eskimo, which is a rather unique position for a half-breed.' As we might expect, this outlier of Eskimo settlement contains survivals of very early cultures; indeed, some of the artefacts collected here seem to belong to the ancient Thule culture, and were actually in use on Southampton Island in the last century.

[1] 'Southampton Island', *Canad. Geog. Jnl.*, January 1942, pp. 17–35.

The caribou seem to have been nearly depleted in the island, but the pelt of the Arctic fox is the chief article of trade of the natives. Seals are fairly abundant in the coastal waters, but perhaps the most interesting mammal is the walrus. Manning observed as many as 2,000 of these huge creatures on Walrus Island, just south of the main island, in August 1936 (Fig. 98). White whales are frequently secured in nets, and are chiefly valued for their blubber. The large whales are rare, and seldom killed, and the narwhales are not often seen, though two were killed in 1937 near Coral Harbour.

The Ungava District in Quebec has an Eskimo population of 1,965, all of whom live near the coast; while the interior of these tundras is almost uninhabited except when the foxes are being trapped. Robinson describes it as a rolling plateau-area of low rocky hills of Pre-Cambrian age, dotted with innumerable lakes and drained by many streams (Fig. 84). In general, the plateau rises fairly abruptly to altitudes of 1,000 to 2,000 feet along the Hudson coasts, and slopes gradually down to Ungava Bay on the north-east. Thus it forms a horse-shoe-shaped upland around this bay. Except for routes along a few main streams very little is known about the interior. There is a number of trading posts along the coast such as Port Harrison, Povungnituk,Cape Smith, Wolstenholme, Sugluk, Cape Hope's Advance, and Payne Bay. Fort Chimo, at the head of Ungava Bay, is perhaps the most important, and is on the edge of the Tundra. An ancient greenstone belt extends inland from Cape Smith which has revealed traces of nickel, copper, and gold, but no mining has developed to date. At Chimo are sixteen buildings belonging to the Hudson's Bay Company, as well as an Anglican Mission and a detachment of the police. Its sole rival is Port Harrison, where there are twenty-one buildings, including those belonging to the radio and meteorological station, the two trading companies, and an Anglican Mission. This gives a white population here of about a dozen, whereas there are only half that number at Fort Chimo. About 400 Eskimos use Port Harrison as their trading centre, a somewhat larger number than favours Fort Chimo to the east. Meteor crater is described on p. 252.

Hudson Strait and Hudson Bay

To reach Hudson Bay ocean currents move south from Foxe Basin, and west along the coast of Baffin Island. They combine near Southampton Island, and move south along the west coast of Hudson Bay; curving at the south end, and then sweeping to the north up the east coast of Quebec Province. This current then seems to move to the east along the north coast of Ungava past Port Burwell, and so joins the important Labrador Cold Current moving to the south. Arrows show these main currents in Fig. 84.

In Hudson Strait the tides seem to be rather high, owing to the funnelling effect of the strait. Ungava Bay at times has tides amounting to 38 feet, and these present many difficulties to the smaller vessels navigating these waters. Owing to the absence of docks, cargoes have to be taken ashore from the ships in lighters. In Hudson Bay the tides are much smaller, and at Churchill amount to about 12 feet. At Port Harrison the tide is smaller again, and is only 3 or 4 feet (Robinson, *loc. cit.*).

Climatic conditions are much the same on the eastern as on the western side of the huge bay. In summer the west is a trifle warmer, and in winter a trifle colder; i.e. it has a more continental climate than the eastern shores, as we should expect. Thus Port Harrison has only about 44 frost-free days, while Chesterfield Inlet on the west coast has 67 days. The east coast has more rain and snow than the west, owing partly to its greater elevation.

In winter the winds over the bay are usually from the west or north-west; and in the summer, owing to the prevalence of Lows, to the south, the winds are variable and not usually so strong. Calms are, however, not uncommon in the winter, owing to the tendency of the dense, cold, polar air to settle over the region. In general, all the climatic factors combined tend to bring Arctic conditions far down on the east coast to latitude 57° N., i.e. as much as 700 miles south of the Arctic Circle. This in turn means that there is little chance of growing any crops in this part of the Dominion.

Navigation in these seas of course depends largely on the sea ice. Sometimes Baffin Bay is clear of ice in August and September, while in other years adverse winds block the northern part of the bay all the year.

In Hudson Bay and Strait the sea ice builds out from the shore for a distance of five to seven miles, generally starting to freeze towards the end of October. The harbour ice attains a usual thickness of about five feet in winter. Even the centre of the Bay freezes over in the winter, with possibly an open area between this mass and the shore ice. In late June the sea ice begins to break up and join the general drift of the currents to the North Atlantic; and during much of July Hudson Strait remains non-navigable. However, the route into the Bay is usually open in August, September, and most of October. About this time the sea ice begins to form again, and the Eastern Arctic is cut off (by boat) for another nine months (Robinson, *loc. cit.*).

NATURAL REGION 20: THE CANADIAN ARCHIPELAGO

The Arctic Archipelago is a series of large islands lying on the continental shelf bordering the Arctic Ocean. These are some of the largest islands known, though they are of little importance in the world economy. The following list is from one of the valuable

reports of the Department of the Interior, from which most of the data in this section are derived (*Canada's Eastern Arctic*, Ottawa, 1935).

AREAS AND POPULATION OF CANADA'S ARCHIPELAGO

Island	Area	Whites	Eskimos
Baffin	201,600	49	1,597
Victoria	79,269	—	—
Ellesmere	75,024	2	8
Banks	25,992	—	—
Devon	20,484	3	8
Southampton	16,936	7	143
Melville	16,164	—	—
Prince of Wales	14,004	—	—
Axel Heiberg	13,248	—	—
Somerset	9,540	—	24
Prince Patrick	6,696	—	—
Borden	4,068	—	—
Islands in Hudson Bay	—	10	422
(Melville Peninsula)	—	4	234

The structure of this part of the Dominion is illustrated in a somewhat simplified form in Fig. 99. All areas to the north of the forested lands are included in the section described in this chapter. The ancient Canadian Shield builds up the southern part of the region, while to the north is a 'basin' or geo-syncline, centering in the Sverdrup Islands to the west of Ellesmere Land. The Shield seems to include much of the west coast of Greenland, except at the northern tip. Lying on these ancient rocks are early Paleozoic rocks, labelled 'Cambrian' in the sketch map, and these build up the northern peninsulas of Boothia and adjacent Baffin Land. Resting conformably on the Cambrian are Devonian rocks near Smith Sound, and Carboniferous rocks in a wide stretch from Banks Land to Ellesmere Land. Some of the larger islands, such as Ellesmere and Baffin Land, have large ice-caps, but none approaches in size that of Greenland, which is illustrated in the map. It covers much of this great island, which has an area of 875,000 square miles. This ice-cap rises to over 10,000 feet in the east, where it is about 8,500 feet thick, and this great 'climatic refrigerator' is of great importance to the adjacent regions of Canada.

As Mecking has pointed out in the best study of this region [1] a great east–west furrow divides the Archipelago into two parts. This furrow or corridor leads to Melville Sound and is called Lancaster

[1] *Geography of the Polar Regions*, Nordenskjold and Mecking, New York, 1928.

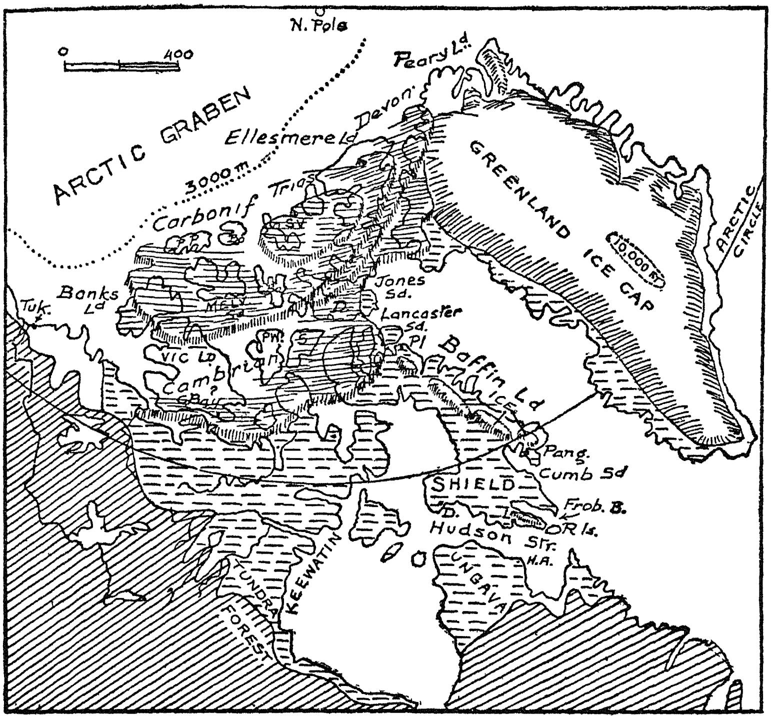


FIG. 99.—Generalized structure of the Archipelago—showing that it is a geological basin with the centre west of Ellesmere Land. The cuestas are emphasized. Depth in metres. (Based on Mecking)

Sound in the east, and McClure Strait in the west (Fig. 99). Immediately to the north of this corridor are the islands named Devon, Cornwallis, Bathurst, and Melville. To the north of this series is another parallel corridor leading west from Jones Sound. This separates the great island of Ellesmere Land and some smaller Sverdrup Islands from the rest. South of the Lancaster ' Corridor ' are Baffin Land, Somerset, Prince of Wales, Victoria and Banks Islands. Tucked away in the angle of Boothia Peninsula is King William Island, the scene of the Franklin disasters in 1848.

Ellesmere, Baffin, and Devon Islands

Ellesmere Island reaches within 7 degrees of the Pole, and is 485 miles long (Fig. 99). It exhibits more variety in its structure than do the more southern islands, for it has been affected by Devonian earth-folding, which extends eastwards to Scandinavia. There are also igneous dikes and knobs in the centre of this large

island. The general plateau-like character of the Archipelago is, however, maintained here. The fold mountains may rise to 10,000 feet in the north, but the ice-caps which cover much of the south of the island only attain about half this height. Three west–east furrows cut the elongated island into four distinct districts, and each furrow ends in a fiord or gulf. There are two settlements, one at Bache Peninsula, about half-way down the east coast on Smith Sound; and the other at Craig Harbour at the south-east corner of the island. Police reside at the latter, but Bache Peninsula has been abandoned since 1933. Eureka and Alert are new posts.

The climate is a polar one; the warmest month having a temperature of about 38° F. while the coldest drops to – 33°. This is, of course, much warmer in winter than, for instance, many places in Siberia, such as Yakutsk (– 46°) or Verkhoyansk (– 59°); but is colder than mainland stations in Canada, such as Chesterfield Inlet (– 24°). The flora of these high latitudes is really remarkable. In the north of Ellesmere Island grass grows over wide areas and furnishes pasture for the huge herbivore, the musk ox. Saxifrages and poppies form veritable flower-beds. The plateaux, however, carry little but lichens. Caribou visit the island in summer, and foxes, wolves, and hares, are plentiful in favoured districts.

Baffin Island is the largest in the Arctic Archipelago. The southern coast is over 400 miles in extent, and is indented with many bays and inlets (Fig. 98). The coasts are generally cliffed, and from the south-east the Grinnel Glacier is readily visible. This covers a considerable portion of the narrow promontory which lies between Hudson Strait and Frobisher Bay. The 'glacier' is really a relic of a once much more extensive ice-cap. It is about 80 miles long and possibly 20 miles wide. Frobisher Bay was visited by Elizabethan seamen as far back as 1576, while in 1615–16 Baffin explored the coasts of the land later named after him. Cumberland Sound, the deep indentation to the north of Frobisher Bay, is 140 miles long and 40 miles broad. It contains numerous branching fiords in one of which is situated Pangnirtung where, as described later, a hospital and police post are maintained.

Baffin Island, like most of the islands, consists of a series of plateaux and lowlands, and in the latter are a number of large lakes, such as Netilling and Amadjuak, which are about 40 miles across. The coastal areas in the south rise gradually from heights of about 1,000 feet near the coast to much higher interior plateaux. On the east coast to the north of Cumberland Sound the plateaux seem to be about 5,000 feet high, with occasional portions 4,000 feet higher. The north coast is extremely rough and broken, rising in the interior to a general elevation of about 2,000 feet. The western shoreline, which encloses Foxe Basin, is for the most part low.

The north-west portion of the island consists of rough plains and rolling hills, and is a favourite grazing-ground of the caribou.

Pangnirtung has been described in detail by J. Q. Adams in the *Geographical Review* (January 1941). The station was established by the Hudson's Bay Company in 1921 to collect the white fox furs from the Eskimos of Cumberland Sound. In 1923 the police post was established here, and a whaling station was removed here in 1925. In 1926 a mission and hospital were added to the settlement. This port is readily accessible from the south, and the annual visit of the Government Ship *Nascopie* in September links it with the Dominion. There were sixteen wooden buildings in 1941, as well as a number of Eskimo tents on the beach in summer. In recent years there have been fifteen white people here, including six women and three children ; so that it is much the most important settlement in the Arctic Islands. (The *Nascopie* was wrecked in 1947.)

There are a number of trading posts on Baffin Island in addition to Pangnirtung (Fig. 98). Of these the chief is Pond Inlet in the far north, near to which are usable beds of Tertiary lignite. Lake Harbour,[1] half-way along the south coast, is perhaps nearly as important as Pangnirtung, and all of these have posts of the Royal Canadian Mounted Police. In addition, there are smaller posts on the island such as Clyde, between Pangnirtung and Pond Inlet, Blacklead Island (closed in 1921), and Cape Dorset at the south-west corner of the big island.[2] There is a radio station on Resolution Island at the entrance to Hudson Strait, and various other establishments have been made as the result of aviation in the recent war, whose sites are not yet known to the public.

Since this island contains some of the largest communities of Eskimos, some notes on their ethnology by D. Jenness may be inserted here. He is of the opinion that a prehistoric group of Eskimos lived around the Bering Strait in the early centuries of the Christian era with a culture unequalled perhaps by any of its successors. This seems to have been followed by three groups spread throughout North America. One extended from north Alaska to Hudson Strait, and another from Ellesmere Island to Newfoundland. A third apparently lived in the plains of northern Canada, and did not inhabit the coast, as seems to be the characteristic of all Eskimos today. Jenness believes that the Eskimos are not an unmixed race, but that certain groups are hardly distinguishable from the Chipeway and Cree Indians of the Interior Forests (*Canada's Eastern Arctic*, Ottawa, 1935).

In modern times they have lost much of their old culture, and

[1] Lake Harbour is described by J. D. Soper in *Geog. Review*, July 1936.

[2] The little-known coasts of Foxe Basin are described by T. H. Manning in *Geog. Jnl.*, May 1943. A new island, 60 miles wide, has been charted.

have taken but too quickly to 'civilized' ways and foods. The skin *oomiak* is replaced by wooden boats, often powered with a Diesel engine. They trap the fox for its fur, which they can trade for groceries at the store, and have to a considerable extent given up the hunting of the seal, which gave them food better suited for their environment. Their caribou clothing is now almost entirely replaced by cotton and woollen materials; and their movable tents and easily replaced igloos were more sanitary than the wooden houses which many of them now prefer.

Trading in the eastern Arctic is still almost wholly in the hands of the Hudson's Bay Company, whose ships have been sailing into Hudson Bay for over 260 years. 'Of the furs taken in this area the pelt of the white fox is of much more economic importance than all the rest put together. A few sealskins, polar bear skins, and ermine pelts are also exported.' Whaling was of great importance in the early days, and was carried on with the help of large numbers of Eskimos. However, a drive for white whales is still carried on at the head of Cumberland Sound, usually in the month of July. As many as 700 of these small whales (*Delphinapterus*) are driven ashore at a time. The skins are exported and used for fine leather goods, while the oil is rendered at a blubber plant at Pangnirtung. The huge walrus is being killed off in this part of the Arctic, but formerly it was quite abundant in Cumberland Sound and Foxe Basin. Some mention may be made of the graphite and mica which are obtained in small amounts at Blacklead Island and near Lake Harbour.

In Hudson Strait the current is predominantly westward along the northern side, and eastward along the southern part of the strait. Along the east coasts of the large islands already described the current is from north to south, and moves to the east in Lancaster Sound and Jones Sound. In general, vessels will find that Hudson Strait and Bay can be safely navigated from July 25th to October 31st. The grain trade from Port Churchill to Europe has been much facilitated by radio stations along this route at Port Churchill, Nottingham Island, Cape Hope's Advance (Ungava), as well as Resolution Island mentioned previously.

Between the two large islands so far considered lies Devon Island, which separates Lancaster from Jones Sound. It is about 250 miles long, and much of the interior is covered with an extensive ice-cap. There is an isolated police post at the south-east corner at Dundas Harbour (established in 1924), where limestones appear capping cliffs of grey gneiss at elevations of about 1,000 feet. In the west of the island most of the rocks seem to belong to Silurian formations, which also extend across the straits to the adjacent island of Cornwallis and Somerset. The extreme north-west of

Devon Island reaches into the Devonian formation, shown as an upper 'saucer' in the map (Fig. 99).

Sverdrup and Parry Islands

In the north-west of the Archipelago lie the Sverdrup Islands and Parry Islands. Most of these are of much smaller size than those so far considered, and none is occupied by trading posts. However, according to Steensby the large herbivore, the musk ox, preferred the western portions of the Archipelago to the eastern, and made its migration to the north far to the west of Baffin Island, on which it does not occur.

The structure of these two groups is given in Fig. 99, where it is shown that the Sverdrup Islands form the centre of the once, perhaps, continuous, geological basin. They are mainly composed of Trias rocks, which are not represented elsewhere in the Dominion until we reach Nova Scotia on the east and British Columbia on the west. Mecking states that this interesting series of rocks formed a plateau dipping north-west. Much later it was faulted and divided into smaller blocks, which were differentially elevated. In the depressions of the Mesozoic sandstones occur patches of Tertiary sandstone with seams of soft coal. Along these faults are extensive extrusions of early Tertiary lavas. Glaciation is rare except in Axel Heiberg Island, which rises to 5,000 feet. The western islands are low, and there is a considerable grassy cover where musk oxen and caribou pasture. Thirty-four species of flowering plants occur on the largest island.

Melville Island is the largest of the Parry group, and here coal was found by the explorer Parry, and used on his ship in 1820. The Carboniferous rocks consist of a series of thick, white and yellow sandstones with coal pockets (Mecking). The islands consist of plateaux usually about 1,000 feet high, often bordered by steep scarps. Melville Island contains about 60 species of flowering plants, and is frequented by all the usual Arctic land animals.

Prince of Wales Island and Somerset Island are of little importance. On the eastern side of Somerset the Silurian rocks rise in cliffs as high as 1,000 feet in places, and the interior of the island has the usual plateau character. Resolute Bay is a new post.

Victoria and Banks Islands

The two large islands in the south-west of the Archipelago may now be briefly described. They are Victoria and Banks Islands (Fig. 98). They are, of course, much more remote from ordinary trade routes than are Baffin Land and Ellesmere Land, and mainly for that reason are still almost unknown except along the south coasts. The summer temperatures are probably a good deal higher than

those of Baffin Land, for the atlas by Brookes and Connor shows the July isotherm of 43° F. running through the north of the western Islands, while all of Baffin Land is much colder. In winter, however, south Baffin Land with – 15° F. is warmer than south Victoria Island (– 22° F.).

As the map (Fig. 99) shows, the north of Victoria Land consists of Carboniferous sandstones, and these contain some seams of coal. On the north-west coast is an area covered by Tertiary deposits carrying plant remains of probable Miocene age. Much of the south-west of the island contains older Paleozoic rocks, from Silurian down to Cambrian. Most of the large island seems to be very low, so that a hill of 800 feet is quite conspicuous. 'The island fully exhibits that barrenness and poverty of life, characteristic of most of the islands further east, because of the sterility of the Silurian limestone' (Mecking).

There are several more or less permanent posts in Victoria Island such as Cambridge Bay, Read Island, and Walker Bay (Fig. 98). Of these the first is much the most important, for a Hudson's Bay Post has been established there for many years. I am indebted to my friend Mr. J. E. Gall (Hudson's Bay Company manager) for the following table, which summarizes life at such a far-north post admirably.

SEASONAL CHANGES AT CAMBRIDGE BAY (69° N.), VICTORIA ISLAND

	Climate	Hunting and navigation	Land travel	Flying
Jan.	Windy (Live on cache-food)	Little	Few mail-runs	Clear
Feb.	Very cold. Ground-drift	Start seal hunt	Eskimos start north	"
March	Snow at end	Ptarmigan from willows	Foxes travel and breed	Overcast
April	Cold with snow	Maximum seal on ice	Caribou north to coast	"
May	Sunny, rare thaw	Snow-bunting	Eskimos inland to caribou	
June	Sunny, then snowy	Canada goose	Eskimo camps to hunt caribou	Good flying
July	Creeks melt, fish run up, at end	Small flowers appear	Drying meat	Water open
Aug.	Best month, some rain	Run of salmon ends. Boat from Tuktuk	Skinning caribou	Good flying
Sept.	Bays begin freeze	Geese go. Navigation ends mid-Sept.	(Seal fat and floats)	Poor flying
Oct.	Frozen in, stormy	Ptarmigan go south		"
Nov.	Cold, clear	Birds gone, trapping foxes		"
Dec.	Overcast	Trap foxes		Good flying

Banks Island is the most western in the Archipelago, and consists mainly of Paleozoic rocks, changing from Silurian to Carboniferous as we proceed northward. Inland the landscape is composed of various plateaux; about 1,000 feet high in the north, and reaching as high as 2,000 feet in the south in places. There is sufficient herbage to support caribou and Arctic hares; but the musk oxen of a century ago have vanished. Coal occurs near Rodd Head on the north coast, and another seam is reported near the Bay of Mercy. No permanent posts have been established on this island.

A few notes on navigation in this part of the Arctic will be of interest. The ice becomes navigable at various dates, so that at times a steamer may pass Point Barrow as early as July 13th though one may be blocked until August 26th. A gale of wind from the north-east will clear the whole Western Arctic coast of ice in two or three days. From 1925 to 1930 the Hudson's Bay Company's ship was able to reach Cambridge Bay from Vancouver and return the same season. In 1931 this ship was caught and sunk on her return trip near Point Barrow. Coronation Gulf is free from ice from mid-July until early October.

The Seas just North of the Mainland

Major Burwash has given us a good account of the waters north of the mainland, leading from Alaska to King William Island, in his memoir *Canada's Western Arctic* (Ottawa, 1931). His journeys occurred during 1925–30 (Fig. 98). His ship left Shingle Point, near the mouth of the Mackenzie, on August 8th; and though a good deal of ice was seen it did not interfere with progress eastward to Baillie Island, the most northern part of Canada's mainland. Here there was a police post and a store, but there is no fresh water, which is hauled as ice from the mainland and stored for the summer. The hinterland is rich in white fox, which are largely trapped by the Eskimos. He found this to be about the limit of western civilization, and here the natives were just giving up the wearing of lip ornaments. Bernard Harbour, opposite Victoria Island, was reached on August 10th, and here also there was a police post, Anglican Mission, and a store. The harbour will take boats of 20 feet draught, and is well sheltered. At the time seven white folk and many Eskimos lived here. Now the ship turned to the south-east and crossed Coronation Gulf, around which are placed four or five trading posts. A police post was maintained at Tree River, and here the Hudson's Bay Company had four employees at their store. The coniferous forest comes rather close to the shore, and the Eskimos use this a good deal for sledge building. (Several of these posts no longer exist.)

Bathurst Inlet is a deep gulf about 100 miles east of Coronation Gulf, with a number of small posts on its coast. On August 16th

Cambridge Bay, across Dease Strait, was reached. Here usually the caribou cross to Victoria Island, but the migration had ceased lately, the Eskimos had left, and so the post was temporarily abandoned. To the east of this point the Eskimos remained almost completely untouched by civilization. The harbour has ample water for boats of 18 feet draught. However, the land is very low, and affords little protection from the strong winds (Fig. 98).

After waiting until September 2nd Burwash proceeded to King William Land in a small gasolene schooner. In the straits a current of 2½ knots was running to the east. The waters here are quite shallow and full of reefs. The post on King William Land was reached on September 5th. Burwash describes the large island as showing ' little else but dead clay interspersed with drab and broken stone, varied by ancient sea-beaches of clean-washed gravel. Rough grasses and many of the hardier Arctic flowers seem to hold a lease of uncertain tenure '. In the interior, however, vegetation is more plentiful.

Amundsen wintered here during 1904–5 at Gjoa Haven on the south-east coast. Burwash remained here during the winter, and was joined by several families of Eskimos. The descendants of the natives who saw the Franklin Expedition as they marched south to their deaths, have all left the island and migrated south to the mainland. Various sledge journeys were made to the mainland, and to sealing-camps on Boothia Peninsula. Here they found a communal igloo 65 feet long, which housed 75 Eskimos. The west coast of Boothia was found to be composed of clay with little rock showing. However, 8 miles inland up the Murchison River, the gneisses of the Shield were reached. Fish and caribou are plentiful in the summer, and musk oxen are occasionally seen. From here Burwash travelled south-east to the post on Repulse Bay, at the north-west corner of Hudson Bay (Fig. 98).

In concluding this description of the Canadian Archipelago, some mention must be made of the several journeys to conquer the North-West Passage.[1] The successful attempt by Amundsen has been described (p. 23), in which he spent over three years passing from the Atlantic to the Pacific (Fig. 98). McClure approaching from Bering Straits was held up in winter quarters on the north of Banks Island for two winters, and though he reached the Atlantic in 1853, it was after a sledge-journey, and in Kellett's ship, which had reached him from the east. The Royal Canadian Mounted Police boat *St. Roch*, an 80-ton schooner, has recently made this famous journey twice, once in each direction (Fig. 98).

On July 23rd, 1940, the boat reached Point Barrow from Bering

[1] ' Conquest of the North-West Passage ', J. L. Robinson, *Canad. Geog. Jnl.*, 1945.

Strait. She struggled with the ice for 18 days, and reached Tuktoyaktuk on August 18th. After patrol work, the boat wintered in Walker Bay on the west coast of Victoria Island. Tuktoyaktuk was again visited on August 5th of the next year, and thence she proceeded east to Cambridge Bay, and later (on August 26th) she reached Amundsen's old quarters at Gjoa Haven. They had a difficult time working north against the ice and were compelled to take refuge at Pasley Bay, close to the Magnetic Pole. Here they spent eleven months, until the following August. They traversed Bellot strait on August 30th, and reached Fort Ross, and finally Pond Inlet in Baffin Land (Fig. 98).

On July 22nd, 1944, Captain Larsen sailed from Halifax on the return journey. He left Pond Inlet on August 17th, and passed along Lancaster Sound, and reached Beechey Island on August 20th. He now coasted along the northern shores of the Lancaster Sound ' Corridor ', and reached Melville Island on August 26th, near Dealey Island, where McClure had been picked up. Here they saw the remains of Kellett's cache (1853). On September 3rd they entered the narrow Prince of Wales Strait, where McClure had been blocked (from the south) in 1851. No ice blocked this narrow passage, and on September 4th they reached the post at Holman Island. They had been only 18 days in traversing the North-West Passage from Lancaster Sound to the open Beaufort Sea! They were held for a week at Tuktoyaktuk, and reached Vancouver Harbour on October 16th, 1944.

Note on the North Magnetic Pole

The site of the North Magnetic Pole was discovered by James Clark Ross during the exploration of Boothia Peninsula (Fig. 7) in 1831. Amundsen confirmed this discovery in 1905. But recent explorations seem to throw doubt on the accepted site of the Pole, unless possibly there are several magnetic poles. In the *Geographical Journal* for March 1946 (p. 108) a map shows the approximate curves of equal horizontal force. These form ovals centred between Somerset and Sverdrup Islands; and they seem to show that the Magnetic Pole is now several hundred miles north of its old position. In August 1947 the Canadian Government sent a party of scientists to find where the freely-suspended magnetic needle dipped vertically. Serson and Clark found that the Magnetic Pole is now in Prince of Wales Island at the head of the western bay, and so about 200 miles north-west of its former site. (See map, p. 21.) Possibly the pole fluctuates with an orbit of about 25 miles radius.

The Western Arctic Islands

A few notes from J. Lewis Robinson's article 'Canada's Western Arctic' (*Can. Geog. Jnl.*, Dec. 1948) may well close this brief account of the empty Northland.

The Western Arctic Islands have both lowlands and plateaux. The lowland basin, rimming the eastern end of the region, extends offshore to include all of King William Island, southern Prince of Wales Island, and eastern and southern Victoria Island. The lowland has recently emerged from the sea, and all the coasts are marked by beachlines. Western and Northern Victoria Island, northern Prince of Wales Island and most of Banks Island are hilly, but the highest elevations reach only to about 2,000 feet. Western Victoria Island has a Pre-Cambrian base, but the central grassy plateau of Banks Island may be post-Silurian in age. (Map, p. 291.)

None of the larger ships now proceeds east of Cambridge Bay. Supplies for the isolated outposts at Perry River and Gjoa Haven are carried across island-studded Queen Maud Gulf by small, Eskimo-owned schooners, and only one or two trips can be made in the summer. The only exported resource of the Western Arctic is the white fox pelt, and in 1943 some 30,000 pelts were obtained. There is a total of less than fifty white residents at the ten tiny posts in the region. Their occupations are those of fur traders, policemen, radio operators, weather observers, and missionaries. The Eskimos totalled 1,582 in 1941.

The period 1930–40 was one of withdrawal. The region had too many trading posts for the few Eskimos living there. Many posts were closed or abandoned, particularly those of independent traders. At the present time (1948) there are only three major settlements in the Western Arctic, namely at Coppermine, Cambridge Bay and Tuktoyaktuk. Smaller centres are occupied at Burnside Harbour, Read Island and Holman Island. Mission stations are located at Stanton and Paulatuk. Trading outposts operate at Perry River and Gjoa Haven.

PART III

THE ENVIRONMENTS AS RELATED TO MAN

CHAPTER XIII

THE SPREAD OF SETTLEMENT

From Cartier to the Conquest in 1759–60

IN Chapter II some account is given of the manner in which the interior of Canada was explored. Such exploration was tied in very closely with the fur trade, so that the development of that industry has been fairly covered already. But the fur-trader who spread through the Dominion in the eighteenth and nineteenth centuries was very different from the farmer in Upper Canada, in the Prairies, or in the fertile valleys of British Columbia. Today we see somewhat the same exploitation of nature, leading mainly to scattered and not very permanent settlement taking place in regard to the mining industry. The opening up of the Dominion is linked with fish, fur, farm, forest, furnace, and factory, and each of these incentives needs to be discussed in a study of the way in which folk have thronged into Canada.

In this brief study only salient features can be considered, such as the birth of some particular industry, and its gradual spread through southern, and at times northern, Canada. As stated in an earlier chapter, it is clear that the Vikings discovered Canada around A.D. 1000. Perhaps our chief evidence of this link between early Canada and Greenland is the discovery of a Viking sword and parts of a shield, in what appears to be a grave near the north shore of Lake Superior, about 1935. The writer is disposed to accept this as genuine.

Our knowledge of the cod fishery goes back to the days of Cabot, who in 1497 was greatly impressed by the abundance of these valuable fish off the coasts of Newfoundland. By the time of Cartier (1534) this fishery was well established, and was chiefly in the hands of the French; partly because, as M. Q. Innis points out in her valuable *Economic History* (Toronto, 1935), the English had no supplies of sun-evaporated salt to preserve the fish when caught.

The general evolution of early trade in Canada has been well expressed by H. A. Innis in the *Canadian Historical Review* (December 1937, p. 376).

The discovery of the abundance of fish in the New World was followed by the expansion of the industry from Europe to meet the demands of countries predominantly Catholic, and with a limited supply of meat products. France prosecuted the industry in relation to her own demands. England was attracted to the Spanish market by the specie obtained from

the New World; and occupied Newfoundland and later New England, as a base for the production of 'dry' fish for that market. The expansion of trade from France to Spain was followed by the occupation of Nova Scotia and the Gulf of St. Lawrence. As a result of contact with the hunting Indians of the interior, the fur trade emerged to meet the demands of metropolitan Paris for luxuries and of the aborigines for European goods. Fur, being a commodity of small bulk and high value, supported a trade carried on over increasing distances to the interior. In the more tropical regions, Spain and Portugal were concerned with treasure, England and France with tobacco, and later, in the West Indies, with sugar.

The technique of production of these various commodities involved sharply differentiated economies. Slaves were taken by English ships from Africa to the West Indies, and supplies and provisions for the consumption of slaves and the production of sugar were carried by colonial ships from the north temperate colonies. New England became an active commercial region, with its prosperity based on the fishing industry and the shipping to Europe, the West Indies, and Newfoundland. France had an expanding fur trade, which handicapped the production of agricultural products on the St. Lawrence, and in turn accentuated dependence of the French West Indies on the English colonies.

It has been stated that Denys of Honfleur was in Newfoundland in 1506, while in the same year Portuguese may have fished all along the east coast. Cartier and members of his crew had been to these grounds before 1534. The second half of the sixteenth century was characterized by the rise and decline of the Spanish fishery, the expansion of the English fishery, and the adjustment of the French fishery to these major developments (H. A. Innis, *The Cod Fisheries*, Toronto, 1940). After the defeat of the Armada, the English took a much greater interest in the Canadian fishery. But owing to the small supply of salt the English developed the drying of the cod on the shores of Newfoundland. The gradual rise of a farm population as the result of this industry in Newfoundland has been briefly described on p. 205.

The next region of settlement was further to the west, when a fur trading post was set up at Tadoussac in 1599; and on the Bay of Fundy in 1604 at Sainte Croix and later at Port Royal. At this latter place some crops were raised, but the first real farming was initiated at Quebec by Champlain in 1608. Louis Hébert, in 1617, was perhaps the first true settler, i.e. a farmer rather than a fur-trader or administrator. The Catholic Missions, soon founded here and in 1642 at Montreal, encouraged agriculture, but by 1663 the colony of New France, after sixty years' occupation, contained only about 2,000 people, and could show only some 3,300 acres under cultivation. French fishermen settled on the Atlantic coast of Nova Scotia; while on the Fundy shores the fertile flats were

dyked and became the rich farms of Acadia. At the Treaty of Utrecht in 1713 France gave up Acadia, Newfoundland and Hudson Bay, and the French fishermen retired from Placentia in Newfoundland to Cape Breton and the Gulf of St. Lawrence.

The early development of Canada in large part turned on the relations with the Indians who lived near the St. Lawrence (Fig. 100). The Montagnais of the Saguenay River were perhaps the first to come in close contact with the French, and were Algonquins of a migratory habit. Cartier's Indians, who cultivated crops at Quebec, were Hurons, and were bitter enemies of the Iroquois living to the

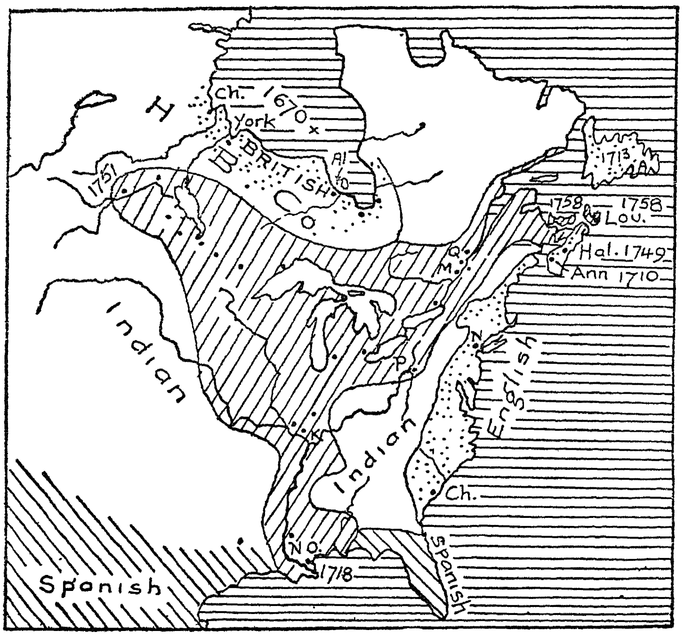


FIG. 100.—The rival nations about 1750. The map shows by large dots the chief French forts controlling the west. (French area is ruled)

south of the St. Lawrence. These latter controlled the great corridor of migration later known as the Richelieu Valley, and containing the river and lake of the same name.[1] This river route reached the St. Lawrence at Sorel, about half-way between Montreal and Three Rivers, at which towns the Ottawa and St. Maurice rivers entered from the north. Thus the forays of the Iroquois could attack these two centres as well as Quebec somewhat farther to the east. During the period 1648 to 1650 the Iroquois raided the

[1] *Canada, the Great River*, by M. I. Newbigin, London, 1926.

Hurons living between Lakes Ontario and Huron, and almost exterminated them. The Neutrals, another agricultural tribe living near Lake Erie, were also invaded by the savage Iroquois. For these and other reasons the French settlers preferred the Ottawa River route to the interior of Canada, rather than the more obvious corridor by way of Niagara and Lake Erie.

In 1663 New France passed from the hands of a private company into the direct control of the King of France. Greater energy in settlement followed, but the problems confronting the French in Canada became still more difficult. To the north, the Hudson's Bay Company was in charge (after it was founded in London in 1670) of all the territory flanking that great bay. To the south were the Iroquois, who now controlled much of the fur lands near Lake Huron, and being in touch with, and friendly with, the English settlers in New England were strongly supported by the latter. The French extended their plan of rule through Seigneuries to the new lands in Canada, and about 300 of these estates were allotted between 1650 and 1750 (M. Q. Innis). By about 1710 there were 16,000 settlers and 43,000 acres under crop along the valley of the St. Lawrence.

The general picture of life in Canada about this period has been well described by M. Q. Innis as follows:

> In New France everyone lived along the river. The habitant farms lay in narrow strips fronting the water, near which stood the houses, while further back lay the pastures, and behind them the unbroken forest. Life on the seigneuries was rough, but it was comfortable and not without pleasures. Among the long rows of heavy, low, whitewashed houses of stone or timber, the seigneur's was only a little larger and better finished than the rest. Each house had a lean-to at the back to hold stores, and an outdoor bake oven. The furniture was home-made, as was the heavy clothing of hand-spun and woven wool. Implements were crude, and as is usual in new countries, farming was careless and bad. The dues from the habitant to his seigneur consisted of a small annual payment, and a fine levied when the farm was sold or inherited by any one other than the direct heirs. The tenant was obliged to bring his grain to the seigneur's mill, and give one-fourteenth as the legal toll.
>
> A journey through an out of the way corner of Quebec today, such as the Isle of Orleans, will show that the life of the habitant still retains many of these characteristics.

We have seen the beginnings of the fish, fur, and farm industries, and the French made early attempts to develop other resources of the country. For instance, considerable deposits of bog iron ore were found near Three Rivers, and furnaces to smelt the ore were started in 1737. Cannon and kettles and other goods in demand locally were cast, but labour costs were high and the iron smelting

did not flourish. However, weapons for the Indians continued to be made at Three Rivers some time after the British occupation.

An industry with more profit to commend it was shipbuilding. The fine timbers along the St. Lawrence were naturally soon in demand for masts and for the refitting of ships; and in 1732 bounties were given for ships built in the colony. Some vessels constructed about this time were as large as 300 tons. But the English were in a much better position to develop the trade of the Atlantic, and shipbuilding made much more progress after the conquest in 1759–60. At the Peace of Paris in 1763, the whole of New France was ceded to Britain, and there were then about 60,000 folk of French origin in the widespread colony.

Meanwhile, British from Boston had invaded Acadia in 1710, and had received the surrender of Port Royal, which was the chief French centre of resistance (Fig. 100). The name of the town was changed to Annapolis, in honour of the English queen; and this portion of Canada thus became British long before the conquest of 1759–63. However, France still held Cape Breton Island, where she built the strong fort of Louisbourg. In the war with France of 1745 the British from New England assaulted Louisbourg, and it fell after a siege of seven weeks. Cape Breton Isle was, however, restored to France in 1748, only to be finally lost in 1763. As a foil to Louisbourg the British founded Halifax in 1749, and many English settlers with their families, together with large military garrisons, have occupied this part of the Dominion ever since. However, the French settlers in what is now New Brunswick were unwilling to give allegiance to the British authorities at Halifax, and in 1755 large numbers of the French Acadians living around the Bay of Fundy were forcibly deported. In 1758 Amherst and Wolfe attacked Louisbourg, and when it was captured the forts were demolished and have never been restored.

The position of the rival nations in eastern North America just before the Conquest of 1759–63, is indicated in the map (Fig. 100). France was hemmed in by the forts of the Hudson's Bay Company on the north, though they had not yet established any permanent posts in the interior. The great French trader, La Corne, was building forts far to the west, and erected one near the Forks of the Saskatchewan in 1751. The exploration of the Mississippi by Joliet in 1673 and La Salle in 1682, was followed by the building of forts at Peoria and Kaskaskia in the next decade. New Orleans was founded in 1718, and so the French controlled the hinterland of the English settlers along the Atlantic coasts. The French also owned the two islands of Prince Edward and Cape Breton long after they had given up Nova Scotia and Newfoundland. All the French and English Territories were united for a brief space from 1763 to

1776, only to be finally split apart in the peace which succeeded the American Revolution in 1783.

The Migrations of the Loyalists, 1780 to 1800

After the surrender of Cornwallis to the Americans and French at Yorktown in 1781, the British were faced with the problem of removing the thousands of Loyalists who had taken the British side during the Revolution. Sir Guy Carleton was placed in charge of the migrations, and he had to find transport and lands for over 30,000 refugees who had crowded into New York. Nova Scotia was the nearest British territory, but Halifax and Annapolis were soon overcrowded. Across the Bay of Fundy many of the Loyalists settled in New Brunswick, and St. John dates from this period.

Ten years after the war ended (says G. M. Wrong) there were Loyalists who were still being fed and clothed at the cost of the Government. It furnished timber, brick, nails, axes, saws, hoes, and spades, and even cattle, so that about 6 millions sterling was spent in relief. With little knowledge of the necessities of the farmer some tragic mistakes were made. Thus 120 Loyalist families landed in 1782 on the rocky shores of Shelburne (south of Halifax), and within a few years the place had 10,000 people. But the soil was poor and the fishing not sufficient for such large numbers, and a year or two later it was almost completely abandoned.

Many of the refugees went farther afield, and reached Quebec and Ontario. Especially in the empty lands of the western province did the newcomers find good land and a fair measure of prosperity. It is said that of 60,000 emigrants, about equal in numbers to the French settlers in 1760, took refuge in Canada. But the French had grown greatly in numbers in the last generation, so that there were now about 100,000 of French culture, while in upper Canada (Ontario) there were only about 25,000 English. In 1791 the British Government decided to divide the original Province of Quebec; and the eastern portion, which was overwhelmingly French, was left to its old laws and way of worship, while Ontario (approximately west of the Ottawa River) was made a separate province under Simcoe as Lieutenant-Governor.

Many of the early colonists in Ontario were soldiers who had fought on the British side during the American Revolution, and when peace came were settled in the new lands west of the French farmers. Thus in 1784 the loyal Regiment of New York migrated to Upper Canada, and took up land in the first five townships west of the Quebec boundary. Another battalion of the same regiment settled to the west in Lennox and Prince Edward counties. New Johnstown (now Cornwall) was the main Government depot for the whole district. Many of the families used the 'Champlain Corridor'

to Sorel, and were carried by the government in open boats up the St. Lawrence to Cornwall.

Some notes on the method of allotting land in these early days will be of value.[1] The French, as mentioned, cut the land into extremely narrow strips, so as to give each farmer access to the river; but the English preferred the plan in use further south, i.e. the area was first surveyed in Townships. These were rectangular areas

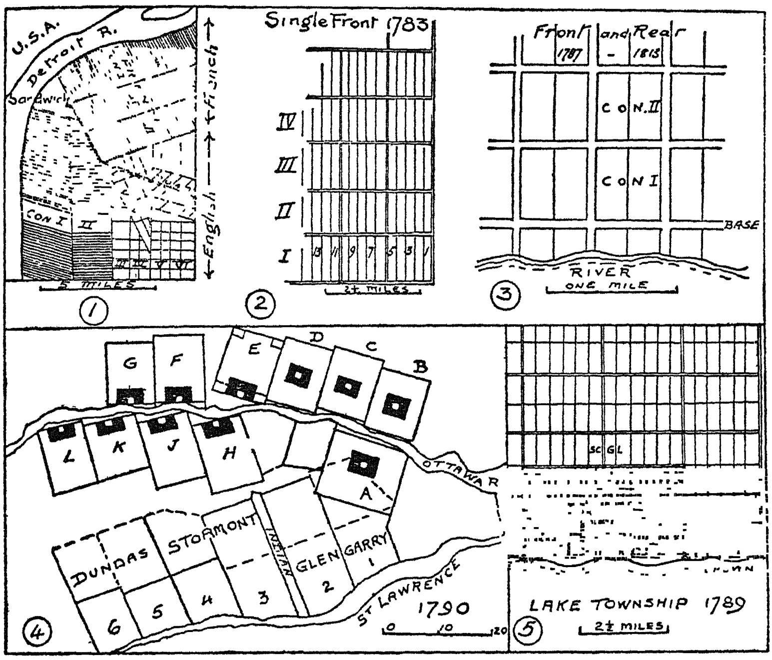


FIG. 101.—Sketch maps illustrating early methods of subdividing new lands in Canada. At '1' the French and English systems are contrasted near Windsor. 'Single Front', 'Double Front', and early Town Plans are sketched. (Based on Fraser, Whitson, and Schott)

with about 10 miles on a side. Each was cut up into about 40 lots, with intervening 'Concession' roads (parallel to the river or base) about 1¼ miles apart (Fig. 101).

About 1790 the districts along the lower Ottawa River, and between Cornwall and Hamilton, were all subdivided into townships, each having a front of about 10 miles along the main river. Moreover, in these early surveys, a portion, usually in the front of the

[1] Carl Schott, *Landnahme in Canada*, Kiel University, 1936. G. Taylor, 'Towns and Townships in Southern Ontario', *Econ. Geog.*, April 1945. G. Taylor, 'The Seven Ages of Towns', *Econ. Geog.*, Worcester, July 1945.

township, was separated for the 'town' itself. In this central portion the lots were smaller, and provision was made for church and school, and for Government buildings. Unhappily very few of these early 'planned towns' ever developed along the lines laid down, though Cornwall (south-east Ontario) is one of the few exceptions. Goderich and Guelph, surveyed and settled about 1828, show a praiseworthy attempt to get away from the 'gridiron' plan, which is almost universal in Canadian towns today.

Glengarry, Ottawa, and the Talbot Settlements, 1800 to 1830

In honour of the chief of the Macdonnells the county containing these earliest military settlements in Ontario was called Glengarry, from the ancestral home in Scotland (Fig. 101). Much later, in 1852, a census showed that there were 3,228 Macdonnells (or Macdonalds) settled in the vicinity. Of course, there were folk from other nations, for instance Lancaster township was settled by English, and the many German names such as Cobourg and Charlottenburg show that the Hessian mercenaries settled also near Glengarry. Each of these soldiers received 100 acres on the river front, and 200 acres behind the frontage, while as much as 5,000 acres was given to a senior officer. By 1818 these small settlements had made considerable progress, as may be judged from the condition of Charlottenburg,[1] where there were at this time 500 houses containing 2,500 inhabitants. This town was served by 6 churches or meeting-houses, 12 schools, 12 stores, 18 taverns, 6 sawmills, and 4 grist-mills.

The early history of the district around what is now Ottawa is full of interest. This region was originally part of the southern county of Grenville, but the northern portion along the Ottawa River was soon separated. It was named Carleton in honour of the famous British general who did so much to save Canada for the British in the American Revolution. Philemon Wright, an American, led a party of lumbermen into the district in 1800, and started cutting the fine pine trees in the vicinity of the Chaudière Falls. He settled on the north bank, now known as Hull. In 1807 he took the first raft of squared timber down the river to Quebec, and so initiated a very important industry.

The township surveyed across the river (now containing Ottawa) was called Nepean, and it was rocky and less attractive than the northern bank. Hence only ten families had settled there by 1818. Many of the soldiers from the 99th Regiment settled about 10 miles south at Richmond in 1818–19; and in this latter year the first steamer came up the Ottawa River to Hull. The site of the future capital of Canada was drawn by lot by two brothers called Burrows

[1] *Early Life in Upper Canada*, by E. C. Guillet, is the best illustrated record of the manners and customs in the early days (Toronto, 1933).

in 1816, but the land was soon sold to Nicholas Sparks, who was later known as the 'Laird of Bytown'. Most of the site was empty and covered by a cedar swamp until a military plan of the Government brought it into prominence.

There was much dread of a future war with the Americans at this time, and it was felt that a shipping route not so close to the United States as was the St. Lawrence, from Cornwall to Kingston, would be a great advantage. It was therefore decided to cut the Rideau canal from Hull to Kingston, so that the Ottawa–Rideau route would be available in time of war. Colonel By was placed in charge of the construction in 1826, and the canal was finished by 1832. Until the numerous locks were made along the St. Lawrence this was the favoured route for cargoes from Montreal to Lake Ontario (Guillet). Bytown had a population of 6,000 in 1847, and its name was changed to Ottawa in 1855, some two years before

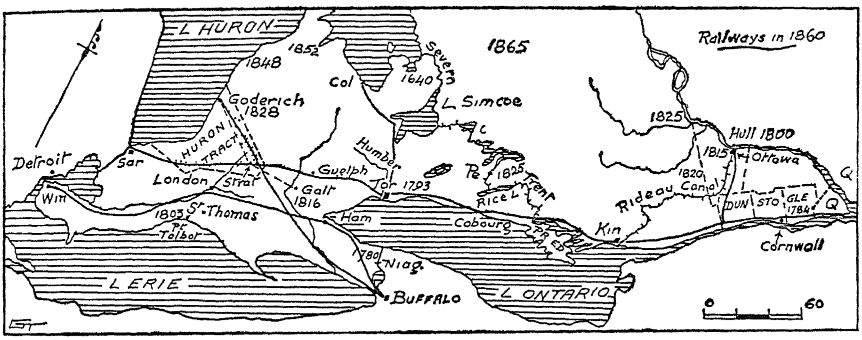


FIG. 102.—Early settlements (shown by dates) in southern Ontario. The canals and the railways built by 1860 are also charted

Queen Victoria chose Ottawa as the capital of the Dominion (Fig. 102).

Central lower Ontario began to be settled in the 'twenties and two mills were erected near Peterborough about 1821. Many Irish were brought out by Peter Robinson in 1825, and settled near Rice Lake. Nearly 2,000 emigrants from Wiltshire in England reached this area in 1831. About the same time the famous Strickland family settled near Lakefield, and the central settlement of Peterborough had a population of 900 by 1838.

A few words may be given to the early history of Toronto at this point. The Humber River was part of a long Indian portage from Lake Ontario north to Holland Landing and Lake Simcoe. Hence the French built a fort at the mouth of the Humber in 1750, which was manned by eight soldiers. It was burnt in 1759, and the next settler was a storekeeper, St. John Rousseau, who started a

trading post on the east side of the Humber estuary in 1770. In 1793 Governor Simcoe proceeded to Toronto, for it had been chosen as the new capital to replace Niagara, which was too close to the United States. The chief factor in the choice was the sandy hook (' The Island ') which formed a good harbour for the small ships of the time. Simcoe decided that the site of the town should be at the east end of the harbour near the entrance of the Don River; and he made a reserve of much of the foreshore to the west. King Street was the first main street. In 1795 there were only twelve houses, one of which is still preserved in the Exhibition Grounds of Toronto. In 1796 the road to Lake Simcoe was open for traffic, and was called Yonge Street. It is today the main artery to the north. The first church in Toronto was erected in 1807 (Fig. 54).

Probably the most interesting pioneer in these early days was Colonel Thomas Talbot, after whom the town of St. Thomas is named. He was an Irish officer in the Quebec Regiment; but in 1801 he made a journey along Lake Erie, and decided to found a large settlement there with the help of influential friends in England (Fig. 102). He chose 5,000 acres, almost half-way along the north shore; and the whole western region, especially around St. Thomas, Port Talbot, and London, owes much to his energy. He himself obtained extra grants for the emigrants he brought to the region, and finally he received 65,000 acres. The coastal townships were settled by Highlanders, the eastern portions by Americans, South Yarmouth by Friends from U.S.A., Malahide by New Yorkers, and London by Irishmen brought out by a distant kinsman. Talbot was given official control of much of the huge Western District, so that by 1831 he could claim that there were 30,000 in his jurisdiction; and this had grown to 50,000 by 1837. St. Thomas in this year had a population of 700. Colonel Talbot's later years were solitary and unhappy, but he lived until 1853, and died at the age of 82 (Guillet).

One of the most ambitious, and on the whole successful, schemes of settlement was carried out in the so-called ' Huron Tract '. This was a triangular region extending west from Galt to Lake Huron near Goderich, which was sold to an English Land Company about 1826. John Galt was one of the moving spirits of the enterprise; and the large tract of land was opened up by a road cut from Galt to Goderich. It crossed the Avon River at Stratford, and the first lot hereabouts was occupied in 1829 (Fig. 102).

Thus the order of settlement was usually somewhat as follows: first the cutting of the main road, which became the base-line of the survey; then the survey of the townships along the base-line; the slow occupation of the small 200-acre lots; the growth of a crossroads village to a town; and lastly the creation of a county out of

from six to twenty townships. Thus Perth County around Stratford was not created until 1851.

The 'Eastern Townships' of Quebec

A great deal of prominence is naturally given to the settlement by refugees from the revolted colonies in the Maritimes and in Ontario. But there was of course an important migration into the regions now included in the province of Quebec, especially into the so-called 'Eastern Townships'.[1] These refugees fled north along

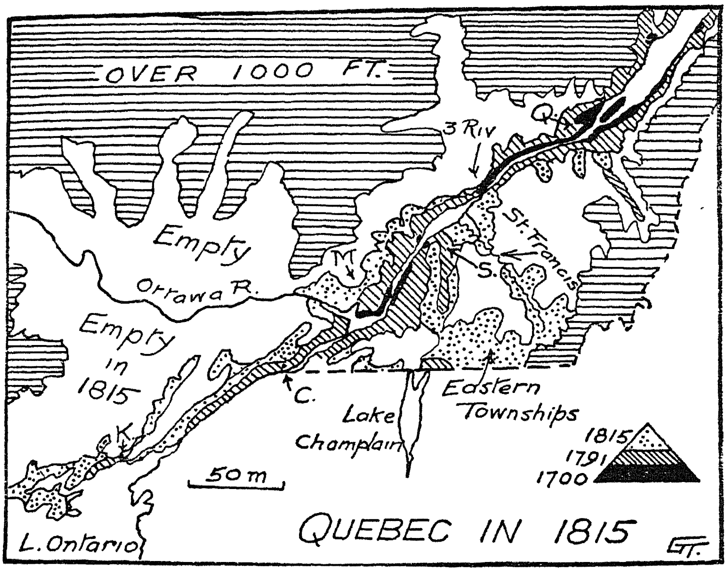


FIG. 103.—Early settlements along the St. Lawrence. Areas settled by 1700 are black, by 1791 are ruled, by 1815 dotted. C. and S. represent Cornwall and Sorel. (Based on Hansen and Brebner)

the military roads to the St. Lawrence; such as the natural corridor of the Richelieu to Sorel, or down the valleys of the Chaudière to Quebec City, or of the St. Francis to Sorel (Fig. 103).

Governor Haldimand in 1783 was averse to settling the newcomers on lands where the boundary was not yet decided, or where the French were the sole inhabitants, and so he favoured distant lands such as those near Niagara and in Cape Breton Island. Grand River in Ontario was set apart for the Indians who had helped the British, and Brantford perpetuates the name of their leader. Many newcomers were transferred from Quebec to parts of Gaspé.

[1] An excellent account of these migrations is given by M. L. Hansen in *Mingling of American and Canadian Peoples*, Toronto, 1940.

However, the settlement of the Eastern Townships could not long be delayed. The Americans had long occupied the lands immediately south of the boundary—which here was merely an astronomical line; and after 1793 restrictions were withdrawn, and within the next few years over 2 million acres of land were ceded to new settlers. There were of course many Loyalists in these new townships, but many folk came from the adjacent state of Vermont. The map (Fig. 103)—taken from Hansen's book—shows where these newcomers, largely not of French culture, settled. The black strips along the great river are the settlements made in the early days, exclusively by the French before 1700. The diagonal ruling shows the spread of the French into the adjacent more attractive lowlands by 1791; but there were some English included in these settlements. The dotted areas were those chiefly occupied in the thirty years after the close of the Revolution, and were settled by Loyalists or by Americans. By 1837 90 per cent of the inhabitants in these Eastern Townships were *not* of French origin; but by 1931, as we shall see later, no less than 82 per cent of the population were French (p. 505).

The Red River Settlement on the Prairies, 1811 to 1821

In the early decades of the nineteenth century the good farmlands of southern Ontario were being settled, and the great deterioration in the soils as the margin of the Shield was crossed was becoming evident. Even today the farms on the Shield and on the Clay Belt are not to be compared in value to the farms on the prairies in the central part of the Dominion. However, the advantages in regard to communications, of course, lay with the settlers in the east, so that they naturally occupied the poor land in Ontario before much progress was made in the prairies. However, the next episode in our brief study of the progress of settlement takes us far to the west, to the district near modern Winnipeg.

About the time of Waterloo, profits were almost non-existent in the famous Hudson's Bay Company. About 1811 Lord Selkirk proposed that a colony of farmers—not fur-traders—should be settled in the hinterland of Hudson Bay, who could grow many of the food supplies needed by the servants of the company. In 1811 he was granted 116,000 square miles in central Canada; extending from Lake Superior nearly to Regina, and bounded on the north-east by Lake Winnipeg, and on the south-west by the Missouri-Red River divide. Selkirk was expected to settle a thousand families in this colony within ten years.

Many of the emigrants came from the Orkneys, others from Ireland; and their ships reached York Factory at the mouth of the

Nelson on 24th September 1812.[1] Here they spent nearly a year, and the first party of pioneers only arrived near the site of Winnipeg early in September 1813. They were, of course, in touch with older fur-trading posts on the Pembina River to the south and at Brandon House farther west. Macdonnell—formerly a soldier settler near Cornwall, Ontario—was selected as Governor of the colony. The harvest in the fall of 1813 consisted of potatoes and turnips, the oats and wheat not ripening properly. Buffaloes were shot to provide food for the new settlement. Owing to the hostility of the North-West Fur Trading Company, and their allies the half-breeds, this early settlement was practically abandoned in 1814. Semple, the new Governor, and a number of the settlers were killed in a struggle with the North-West Company in June 1816.

Lord Selkirk himself arrived at the Red River Settlement in 1817, and did his best to forward the aims of the young settlement. He endeavoured to introduce sheep, realizing that wool was a profitable crop in the new colony of New South Wales. But he met with little encouragement from the fur-trading companies. Soon afterwards in 1821 the two rival companies united, and Selkirk died. The settlement, which might have led to a much larger proportion of the west remaining in the British Empire, if our folk had expanded throughout the Red River valley, made very little real progress for another fifty years. The company discouraged agriculture even in the Selkirk colony, which had been sold back into the possession of the company. Indeed, it was not until the company in turn sold its rights in the land, for 300,000 pounds sterling in 1869, that new progressive factors affected the prairie lands.

The Period of Canals, 1800 to 1848

It is almost impossible to exaggerate the importance of the waterways in the early days of the Dominion. The great Gulf of St. Lawrence led to the fine river of the same name, and this drained the largest group of lakes in the temperate world. The canoe of the Indian was adopted by the fur-trader, and was used long after the introduction of the wooden bateau and the larger Durham boat early in the nineteenth century (Fig. 109). But this excellent system of waterways was blocked at many points, even in the east, by rapids, and at Niagara by high falls ; and these necessitated the construction of canals if the water-routes were to be used on a large scale. Moreover, Governor Clinton of New York was building the Erie Canal (1817–25) linking the Hudson River at Troy with Lake Erie at Buffalo. It was feared with good reason that the traffic of

[1] A. S. Morton, *A History of the Canadian West*, 986 pages, Toronto, 1939.

the middle Great Lakes would now reach the sea *via* U.S.A. rather than along the St. Lawrence.

In the last years of the eighteenth century some attempt had been made to build small canals where the rapids baulked transport between Montreal and Kingston. The worst rapids were those nearest Montreal, i.e. the Beauharnois and Cornwall rapids, but though the primitive canals were improved a little in 1817 they would only permit the passage of very small boats. Of much the same character was the lock built at the mouth of the Ottawa River about 1816.

The most obvious obstruction in the St. Lawrence was the Lachine rapid close to Montreal, and accordingly a canal on a somewhat larger scale than the early samples was cut here between 1821 and 1825. The rapids on the lower Ottawa River near Hawkesbury were circumvented by three small canals about 1834. A rather complex system of natural waterways links the water of Georgian Bay with the Trent River; and this system is indeed the result of a former great outlet of the Upper Great Lakes during the Ice Ages. About 1833 the old channels and lakes between Lake Simcoe and the Trent River were deepened to form a long water-route. But the project was never completed, though around 1907 some short railway portages to carry small ships were constructed along the Severn River, which enabled light cargoes to be taken from Trenton to Georgian Bay. The Rideau Canal was, however, completed in 1834, so that small boats drawing 5 feet could be lifted over the divide by 46 locks, and so proceed from Ottawa to Kingston (Fig. 145). (See *Rideau Waterway*, R. Legget, Toronto, 1955.)

Much more important than most of these small canals was the first Welland Canal, which was completed about 1829, largely owing to the energy of a local resident, W. H. Merritt. The difference in elevation between the level of Lake Ontario and the highest part of the canal was 326 feet, and 34 locks were necessary to lift the ships over this 'hump' (Fig. 146). The first Welland Canal ran from Port Dalhousie on Lake Ontario to the Welland River, then along this river to the upper Niagara River at Chippewa, and so into Lake Erie. A few years later the canal was extended to Port Colborne on Erie, and in 1845 ships drawing 9 feet could use the deepened waterway.

During the 'forties the task of cutting larger canals along the main St. Lawrence waterway above Montreal was carried out.[1] The Beauharnois section was done in 1845, and that at Cornwall about the same year. The three upper canals below Prescott were ready by 1848. A few years later, in 1855, the Americans cut a deep

[1] G. P. Glazebrook, *A History of Transportation in Canada*, Toronto, 1938.

canal to bypass the falls at Sault St. Marie between Lakes Superior and Huron (Fig. 143). This was used by Canadians until the Dominion constructed their own canal in 1895 on the other side of the river. These canals along the main route of the St. Lawrence are still of great importance, and indeed the completed sea-way Canal above Montreal is on a still grander scale. But most of the smaller canals have lost almost all their usefulness with the extension of railways and motor transport. The Rideau and Trent canals are necessary to the few mills which still use simple water-wheels along their courses, and pleasure boats are numerous in summer. But as conveyors of important cargoes they have been quite superseded. (The topography and commercial aspects of the canals are discussed in Chapter XIX.)

Early Lumbering in Canada, 1800 to 1850

One of the great assets of Ontario and Quebec—and indeed of all the early settlements—was the abundance of good timber. Unfortunately this had to be removed to make room for crops and pastures; and in some instances it was done without much forethought. For instance, in Norfolk County, half-way along the north shore of Lake Erie, there were splendid stands of pine, in some ways the best of the conifers. This was ruthlessly cut and burnt, though it grew on poor sandy soils of very little value for crops, or indeed for anything but growing pine. Today the Province is bringing these sandy districts back into pine forests at great cost, which will not equal the primitive forests in value for many years.

However, in many parts of the new settlements, especially near the main waterways, the good lumber was taken out before the farmers came into the region. Along the Ottawa valley the farmer soon followed, and found that the logging camps gave him a market at his own back door. Of course, there soon came a time when the best timber had gone; for instance, in the district east of Kingston the trade in lumber had almost disappeared during the later 'thirties. When the Welland Canal was opened about this time it enabled the farmers to get their timber to markets in U.S.A. and elsewhere. The northern counties like Simcoe, to the west of Lake Simcoe, had to wait for the arrival of the railway in the 'fifties for the development of an export lumber trade. As described in another section, the Bruce Peninsula was a decade or so later in cutting its best timber. Somewhere around 1860 the lumber industry in upper Canada *south* of the Shield was yielding place to the export of agricultural products. One interesting forest product was potash; which was early exported to England for use in various bleaching factories. Many farmers, especially in the 'Eastern Counties' (southern Quebec), found that this product of the burning of their trees gave them something that

was readily transported, and brought in much-needed cash. But only the so-called 'hardwoods' such as maple and oak gave the best potash, and these forests had been almost totally cleared from the St. Lawrence valleys by about 1850. Moreover, chemists were finding much better materials than potash from burnt trees to aid them in their bleaching industry, so that the potash industry soon vanished after 1850. The later phases of the lumber industry are linked with the expansion of the railways throughout the margins of settlement in Canada. This phase of our economic history is still characteristic of the southern portion of the Shield in the middle of the twentieth century.

The Development of the Canadian Railways, 1836 to 1876

The chief period in which canals were of prime importance in the Dominion was from 1820 to 1850. During the last of these decades the spread of railways showed that a much more flexible form of transport was supplanting the canal, which could only be built economically in a few specially endowed districts. The first railway of note was opened in 1825 in the north of England, to carry coal between Darlington and Stockton. In 1832 the Baltimore and Ohio Railway in U.S.A. was using steam locomotives for the first time. Within a few years the new technique was in use in Canada, at first in 1836 to transport goods past the rapids on the Richelieu River in Quebec. In 1847 another short line was constructed to connect Montreal with Lachine; but the main developments occurred in the 'fifties. During the period 1850–3 a railway was built to link Montreal with the ice-free port of Portland in Maine (Fig. 150). This was not only the first long Canadian railway, but the first international line in the world.[1]

In the 'fifties there was much rivalry between railway companies in Ontario. One of the earliest lines in 1855 linked Toronto to Collingwood, so as to draw the trade of the upper Great Lakes to the capital of Ontario. The Great Western Railway took advantage of the geographical fact that the peninsula of southern Ontario lies across the short route from the state of Michigan to Buffalo. Accordingly in 1855 a railway was constructed linking Windsor (and Detroit) to the railway lines which already served Buffalo. A few years later (in 1858) another railway was extended from Buffalo to Goderich.

The most ambitious of these early railways was the Grand Trunk, which opened its main section from Montreal to Toronto in 1856. This line was soon extended in both directions; reaching Sarnia, and so linking with the Michigan railways in 1859; and extending to the east about the same time over the great bridge at Montreal

[1] G. P. Glazebrook, *History of Transportation in Canada*, Toronto, 1938.

to Rivière du Loup. During the 'seventies the chief railways constructed were links in the ' Inter-colonial Railway ' from Rivière du Loup (*via* Campbelltown and Moncton) to Truro and Halifax. This through line was in operation in 1876, though various sections had been in use for some time before this date (Fig. 150). (The railways are described more fully in Chapter XIX.)

Later Settlements in Southern Ontario, 1850 to 1870

Although the first clearings in the farmlands of southern Ontario were made just at the end of the 18th century, it was fifty years

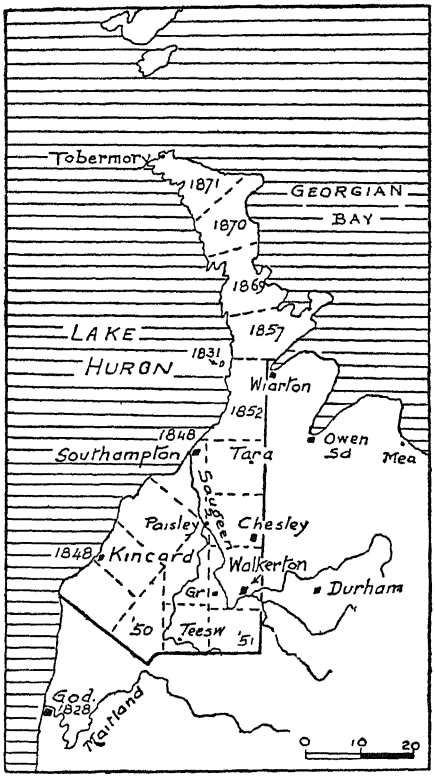


FIG. 104.—The county of Bruce, Ontario—one of the last counties in the Paleozoic area to be settled (1848–71). The townships are shown by broken lines

before the forests on the northern margin of the Paleozoic rocks were turned into farms. As shown in earlier chapters, the boundary between the Paleozoic rocks and the Shield—which runs from Midland to Kingston (Fig. 54)—is the chief factor in the history

of settlement of southern Ontario. Farming is much more difficult to the north of this line. However, as a sample of the methods of settlement in the southern section of Ontario, we may consider how folk developed the county of Bruce. This is the most northern of those built of Paleozoic rocks and includes the long promontory which separates Lake Huron from Georgian Bay (Fig. 104).

The story of the settlement of Bruce follows logically after that of the Huron Tract described on p. 316. During the 'thirties and 'forties Goderich was the chief port and centre on the coasts of Lake Huron; and fishermen were the first to move farther north, as might be expected. A fishing station was the first settlement on the islands just at the root of the Bruce peninsula in 1831. By this time the district of Durham to the north-west of Goderich was being settled, and farmers pushing towards the west coast near Kincardine were the first to take up land in 1848. A few blocks were also occupied in this year at the mouth of the Saugeen River at Southampton. All this region north of the Huron Tract was known as the 'Queen's Bush', and a fair road was constructed from Durham to Kincardine about 1850.

As we saw in the case of the Huron Tract, the first farms were allotted along the main road and along the coast, mainly because the surveys were first carried out here. About 1849 three new counties were proclaimed, i.e. Bruce, Huron, and Perth. The former was at first divided into eleven townships, each as usual about 10 miles across. In 1851 many farms developed along the lower Saugeen River near Southampton. Next year over 100 Scottish settlers arrived, who spoke only Gaelic; and they cleared land just south of Kincardine. Many Germans moved out of Waterloo (in the south-east) and took up land at Formosa to the east of Kincardine about the same time. N. Robertson, in his valuable *History of the County of Bruce* (Toronto, 1913) describes the struggles between Greenock, Kincardine, and Walkerton as to which should become the county town. Walkerton, dominated by an energetic mill-owner, Joseph Walker, who practically founded the town around 1850, was successful in this struggle.

The northern townships were settled during the 'fifties, and the cutting of spruce and pine gave rise to many sawmills between 1855 and 1865 in the south. In the peninsula, the period from 1880 to 1905 was perhaps the zenith of the lumber period. Grist-mills were usually built within a year or two of settlement. The little town of Paisley, for instance, had three sawmills and a grist-mill by 1857. Walkerton had, in addition, tanning, planing, and woollen factories within a few years.

Railways reached the region in the 'seventies, arriving at Southampton in 1872, and at Kincardine in 1873 (Fig. 104). In

1881, Tara, near Owen Sound, was linked to the railways of the Province. As early as 1856 Kincardine was supplied with good wharves, and became a great grain port for wheat from the west. The Saugeen—though a small river—had a small tourist steamer placed upon it, which plied to Walkerton in the 'eighties. By 1880 the County of Bruce contained a population of 65,000. Since this date the increase has been slower, and indeed many of the younger generation took part in the rush for the western prairies in the 'nineties.

Factories and Mines from 1860 to 1880

The early industries were naturally simple, and closely connected with the products of the region concerned. At first, as we have seen, every district had its grist-mill and its sawmill, worked by local water-power, often due to a dam across a small river. With the advent of railways it was easy to bring in coal, and to use steam power. But the small mills sited on the rivers had the advantage of a good start, and so, for instance, we find an early development of industry along the Grand River in southern Ontario. In 1857 Galt in this area had factories producing staves, shingles, pails, doors, and furniture as well as planing mills. Sawn lumber was easier to transport and began to replace 'squared timber' early in the 'seventies. Many of the streams flowing south into Ontario and Erie were carrying timber to lake ports, and helping to produce sawn timber during the 'seventies. In 1874 there were 57 mills back of the northern shores of Lake Ontario (M. Q. Innis).

Shifts in industrial affairs are always occurring, and early in the 'eighties the interest in sheep declined, as home-made woollens went out of use, and the expansion of cattle in the direction of dairies became quite general. Belleville in the Kingston area, and Stratford and Ingersoll near London, were pioneer districts in the export of butter and cheese around 1881. Tobacco became a valued crop to the north of Lake Erie during the 'seventies; and the mild climate of the Niagara Peninsula was found to favour the growth of fruit. Some of this fruit was exported to England around 1877, helped by the growth of refrigeration.

This period was also notable for a great increase in the development of the mineral resources of eastern Canada. Oil had been found in wells drilled near Sarnia in 1859, and more was obtained from Petrolia in the same district around 1865. Salt springs were discovered here, and farther north at Goderich, during the 'seventies. The precious metals were discovered in some abundance in Eastern Canada, though no fields as extensive as those worked today came to light. There was a minor gold rush in the Chaudière valley south of the city of Quebec after 1863; and very rich silver ore

was obtained in the 'seventies from Silver Islet just off Fort William. Both of these fields are now abandoned. Asbestos was first worked on a large scale about 1880 in the huge deposits of Quebec near Thetford. These still furnish the chief supply of the world.

A very interesting mineral deposit is that of apatite, one of the few sources of the irreplaceable element phosphorus. The latter, since it is vital for all plant growth, is of far more value than gold or silver. Apatite occurs in ancient granites, and has long been obtained from the extension of the Shield just east of Ottawa. One hopes that deposits as large as those of the Kola Peninsula in Russia may be found later. No important sources of iron ore were discovered in these decades, though small mines near Madoc were replacing the ore worked out at Three Rivers. It was not till around 1880 that we see the beginning of the manufacture of cotton textiles and boots and shoes in any large quantities, and this type of manufacturing is more characteristic of a slightly later period.

The Boundary Changes in the Various Provinces of the Dominion, 1850 to 1895

The eleven administrative divisions and provinces of the Dominion have only gradually been settled and administered from various Dominion and provincial capitals. However, with the advent of Federation in 1867, the administrative picture was not unlike that of today, as regards the most important part of the Dominion. These administrative units are listed in the table on p. 327, with some notes on their evolution.

By far the best way to obtain a clear idea of the numerous changes in the territorial boundaries is to consult the fine series of maps given in L. Burpee's *Historical Atlas of Canada* (Toronto, 1927). The boundary between U.S.A. and Canada in the west was not accurately defined until 1846, when the 49th parallel was chosen as the limiting line. As explained in an earlier section, Vancouver Island was made into a separate colony in 1849 (Fig. 105), but the rush of settlement to the mainland, as the result of the discovery of gold along the Fraser River, led to the creation of a separate colony of British Columbia in 1858. To this the older region of Vancouver Island was added in 1866.

Quite important changes in the administration of the Dominion took place as the result of Confederation in 1867. Ontario and Quebec were more specifically divided, for they had been rather closely associated since 1840. At first only the eastern provinces, excluding Prince Edward Island (and Newfoundland), joined the Federal Union. But British Columbia came in, on the promise of a transcontinental railway, in 1870; and a small new province of Manitoba was admitted the same year. Prince Edward Island

CONSTITUTIONAL CHANGES IN CANADA

Province, &c.	Date of creation	Notes on boundaries	Present limits
Nova Scotia	1713	Cape Breton separate 1784 to 1820	1820
Quebec	1763	Much extended to the north, 1898 to 1912. Loses Labrador to Newfoundland in 1927	1927
Prince Edward Is.	1769	Separated from Nova Scotia	1769
New Brunswick	1784	*ditto.* (Modified, 1842)	1842
Ontario	1791	Separated from French Canada, 1791; much extended to north-west in 1912	1912
British Columbia	1858	Vancouver Is., 1849; added to B.C. in 1866	1866
Manitoba	1870	Separated from NW. Territories; much extended to north in 1912	1912
Saskatchewan	1882	Extended by half of Athabasca, 1895; linked to Assiniboia in 1905	1905
Alberta	1882	Half of Athabaska added 1895	1895
Yukon	1895		1895
NW. Territories	(1820)	In 1895 divided into Mackenzie, Franklin, and Keewatin. Much of Keewatin lost in 1920	1920

joined in 1873. All the rest of Canada, including the northern parts of the Shield and almost the whole of the Prairies, &c., was known as the North-West Territories. From this huge domain the new provinces were rapidly carved during the next thirty years (Fig. 105).

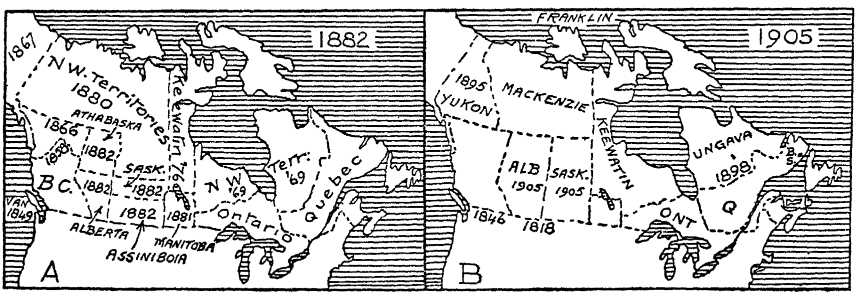


FIG. 105.—The evolution of the provinces and territories of Canada. Blanc Sablon (B.S.) is indicated. (Based on L. J. Burpee)

Keewatin, along the east coasts of Hudson Bay, was separated somewhat indefinitely in 1876, and split the Territories into halves. This was precisely the time when the vast agricultural resources of the prairies were becoming known, and a stampede of farmers

flocked to the new lands of the west. These settlers exerted pressure to acquire self-government, and each decade saw new provincial boundaries set up in the west. Assiniboia and Athabasca (Fig. 105) were new districts erected into separate administrations, only to be incorporated into the Provinces of today in a few years. A glance at the map will show the changes better than any description.

In 1895 the vast *northern* Territories were subdivided into districts, which are much the same to this day. Yukon is under a somewhat separate control, while Mackenzie, Keewatin, and Franklin (Fig. 105) are rather closely associated. The northern portion of present-day Quebec was in this year erected into the district of Ungava. A few years later the south-west corner of Ungava was attached to Quebec. Meanwhile, Newfoundland had rather ill-defined rights to Labrador, so that the eastern boundaries of Ungava and Quebec were by no means certain at this date.

Great changes were made in the regions around Hudson Bay in 1912. The boundaries of Manitoba were pushed north at the expense of Keewatin, so as to give that province several ports on Hudson Bay. At the same time Ontario was increased in area by the addition of the Severn basin, which formerly formed the southern district of Keewatin (Fig. 105). Ungava was handed over to Quebec, though the native peoples are still controlled to some extent by the Dominion authorities of the Territories. The picture of the Dominion thus became much like what it is now, save for Labrador.

Labrador has always been somewhat of a 'No man's land' since its discovery by the British. In 1713 it was divided between the French and English, but the boundary was ill-defined. It went to Quebec in 1774, but was given to Newfoundland in 1809. Later, in 1825, the north coast of the St. Lawrence, as far east as Blanc Sablon (Fig. 105), was handed over to Quebec quite definitely. But the vast hinterland, comprising the basin of the Hamilton River, was claimed equally by Quebec and Newfoundland. Finally, an appeal was made to the Privy Council in London, and it ruled in 1927 that the main river divide (height of land) of all the Labrador Rivers (north of Blanc Sablon) should be taken as the eastern boundary of Quebec. This added about 100,000 square miles to Newfoundland; and the new area includes Goose Bay, one of the largest airports in the world, and rich iron ore in the far west.

The Prairies—from Selkirk to the C.P.R.; 1820 to 1870

It is well to remember that agriculture had made some progress in the prairies far to the west of settled Canada, long before the Canadian Pacific Railway brought the region within reasonable distance of Ontario and Quebec. In 1820 Franklin records that he saw at Fort Carlton (Prince Albert) five acres in cultivation, which

gave ample returns of wheat, barley, oats, and potatoes. This is not far from the northern edge of the wheat-belt in 1946! As far back as 1833 the Hudson's Bay Company stated that they intended to rely on the croplands of Peace River for the flour needed by their posts in the north-west (A. S. Morton).

The great difficulty in these pioneer lands then, as always, was to find crops which would pay for the vast cost of transporting them to the regions of their consumption. This was possible with furs, but with few other products of the West. In 1832 Simpson had hopes of an export of tallow, from herds grown on the prairies or even from the wild buffaloes. Sheep were introduced to give a return in wool. Both these commodities became valuable exports from Australia about this time; but no trade developed from the Canadian prairies.

French missions were established in 1818 at St. Boniface (Winnipeg), largely among the half-breeds and Indians. These men were mostly occupied in hunting the buffalo, so as to provide meat for the fur-traders. In 1818 the population of the Red River Settlement was about 400, and consisted of Scottish farmers, German soldiers, and rather ignorant Swiss emigrants. In 1827 more than 200 of the settlers, including most of the Germans and Swiss, moved south along the Red River valley into the States. Governor Simpson favoured *Lower* Fort Garry on the rapids of the Red River as a better site for the main settlement, and built the large stone fort, which still exists, between 1833 and 1839. But this settlement never replaced the one near the Upper Fort, now called Winnipeg.

In the early 'forties there were several settlements along the Red River. Upper Fort Garry was the chief centre, with its British and French quarters. Five miles to the north was Kildonan, where a number of industrious Scottish settlers had their farms. Near the huge fort, about 20 miles north of the main settlement, a number of retired servants of the company had their homes; and near here was an experimental farm for the Indians. The possibility of war with the States in connexion with the quarrel over the Oregon Territory led to 500 soldiers being sent to Red River in 1846. They were withdrawn in a few years, but produced a much greater interest in the outlying settlement. Again in 1857 a hundred soldiers from the Canadian Rifles were stationed on the Red River to counter the advance of the American garrisons just south of Pembina about this time.

About 1856 an entirely new phase of the development of the prairies began, when commissions commenced to study the resources of the region in a scientific fashion. In 1857 and 1858 Captain Palliser examined much of the country between Lake Superior and the Rockies; and first drew public attention to the three cuestas,

which are the main feature of the topography of the prairies (Fig. 126). He gave a valuable report on the region, and endeavoured to grade the country in three classes. He had a poor opinion of the drier portion of the prairies, but pointed out that the best belt was an intermediate, somewhat crescentic, zone between the southern semi-arid country and the northern coniferous forests. He showed his wisdom by relying on the native vegetation as an indicator of farming possibilities; and may well be compared with Surveyor Goyder who was doing similar research in Australia about this time.

Professor Hind of the University of Toronto should also be remembered in this connexion. He was of the opinion that much of the region south of Qu'Appelle was not fitted for settlement. He noted the old glacial channel at Elbow on the South Saskatchewan, and suggested that a canal should be made along this depression to link the big river to Winnipeg!

By this time population had spread westward in the States, and the easiest way to reach the Red River was by way of the upper Mississippi and St. Paul (Fig. 151). Many Canadians in the east felt that it was vital that there should be better communication between Winnipeg and the east; and steamer traffic of a regular character on Lake Superior was initiated about 1858. There still, however, remained the unattractive region of the Shield between Fort William and Red River, which had no easy line of communication. One further trouble was that the directors of the Hudson's Bay Company were opposed to any large immigration into their fur-trading areas, since they believed it would ruin the trapping.

In 1869 the Hudson's Bay Company handed over to the newly created Dominion most of their administrative rights, and confined their attention thereafter to trading of one sort or another. To bind the new territory to the rest of the Dominion surveyors were sent to plan a road from Fort William. These folk seem to have led the Indians and half-breeds to believe that they were about to deprive them of their lands. As a result there broke out the first Indian revolt under Louis Riel. Not until much blood had been shed was this rebellion stamped out; but it had one good result in that it hastened the building of the transcontinental railway during the 'seventies.

British Columbia; 1850 to 1880

The early history of this portion of the Dominion has been given in the chapter on inland exploration (p. 33), but not much stress was laid on the economic developments, which may now be briefly discussed. As early as 1827 Fort Langley had been established on the delta of the Fraser, while Kootenay House (1807) was just north of that interesting bifurcation of the Kootenay River at Canal Flat,

which is described on p. 186. In 1858 the Hudson's Bay Company had eight forts in British Columbia, five being even earlier than Langley. These were St. James, Fraser, and George, all near the Prince George of today and built in 1806–7; Kamloops (1812), Alexandria (1821); and two in the south, only a few years old by 1858, at Yale and Hope (Fig. 65).

In 1858 the rush to the Fraser goldfields set in, and steamers were soon carrying miners, mostly Americans, up the Fraser River. Other emigrants crossed the mountains, *via* Whatcom and Okanagan. There was some fighting with the Indians who lived near the Fraser Canyon above Yale, but it was soon ended. In the next few years the miners moved north; and the most permanent mines were found in the Caribou Mountains, some 250 miles north-east of Vancouver. The great Caribou road was constructed between 1862 and 1865, and stage-coaches served it regularly. But by 1865 the gold stream began to dry up, and the colony was in financial difficulties.[1]

During 1865 and 1866 considerable progress was made in laying a telegraph line through the region, with a view to reaching the Old World *via* Bering Straits. Telegraph Creek, far north on the Stikine River, is a survival of this project. However, it was abandoned when the Atlantic cable gave an easier means of communication with Europe. The isolation of the region gave some support to a few colonists who urged annexation by the United States in the late 'sixties, but British Columbia willingly entered the Dominion in 1871, largely owing to the promise of the authorities to build a transcontinental railway. This was supposed to start within two years, and to be completed within ten years; a contract which was by no means carried out owing to various obstacles. The story of the Canadian Pacific, however, is given in another section (p. 480).

Lumbering naturally soon attracted the attention of the early settlers. Several mills were in operation on Vancouver Island, at Victoria and especially at Port Alberni, by 1860. The latter mill was soon sending sawn timber to California, and later to all coasts of the Pacific including Australia. Yale had a mill in 1858, and many others followed in the next decade. But the great expansion occurred with the building of the Transcontinental Railway after 1880 (Fig. 65).

Even before the Hudson's Bay Company had abandoned its forts on the lower Columbia it had been exporting fish to London (Howay). This trade was continued when Victoria became the headquarters of the company. But it was not till 1870 that the first cannery was established at New Westminster. By 1882 the annual pack on the

[1] *British Columbia and the U.S.*, by Howay, Sage, and Angus, Toronto, 1942.

Fraser River amounted to 250,000 cases, each including four dozen one-pound cans.

This brief account of the early days of British Columbia may be closed with a description of an overland journey, made in 1862, by gold-seekers from Ontario and elsewhere. It illustrates the difficulties of travel before the Canadian Pacific Railway was constructed. They used the U.S. railway to St. Paul, and stage and steamer to Fort Garry. About 200 folk left Fort Garry on June 2nd in 90 Red River carts, each drawn by an ox. They reached Fort Edmonton on July 21st, and here proceeded on horseback by way of Jasper House and the Yellowhead Pass to the Tête Jaune Cache, where they arrived on August 28th. Here they divided into two parties. One descended the Fraser River on rafts, and reached Quesnel (near the mines) on September 11th. The other party tried to cross the mountains; but had to take to the Thompson River, and reached Kamloops on October 11th.[1] Several members were drowned as the rafts tried to shoot the rapids (Fig. 65).

Building the Canadian Pacific Railway, 1871 to 1885

For nearly a decade before the first sod of the railway was dug in 1880, highly important work in the form of surveys had been carried out. Sandford Fleming divided the route into three sections, and surveyors and explorers worked independently in each of these divisions (Fig. 151). The eastern section was between Lake Nipissing (Callendar) and the Red River. The middle section comprised the Prairies as far as the Rockies; and it is of interest that at first the favoured pass was the Yellowhead, far to the north of that actually used by the railway. The third section was in British Columbia. Here also there were several routes proposed; and for a time there was a strong party which wished the railway to end at Esquimault, the new naval port close to Victoria. This project involved reaching the Pacific at Bute Inlet, and then crossing the Narrows by a huge bridge to Vancouver Island.

By 1878 Fleming had decided to use the route down the Fraser River to Burrard Inlet. In this year some 85 miles of railway had been completed in Manitoba from Pembina to Selkirk, and by 1880 about 100 miles was ready west of Red River, while about the same had been opened in British Columbia. Indeed, by 1879 over 14 million dollars had been spent on the railway, though little of it was open for traffic (Glazebrook, *antea*). In 1880 a new contract was arranged, by which the constructing company received 25 million dollars and huge grants of land. These were to be alternate sections of 640 acres, 24 miles deep, on either side of the railway between Winnipeg and Jasper House (in the Rockies near Yellowhead

[1] *History of British Columbia* by A. Begg, Toronto, 1894.

Pass). In 1881 Van Horne became General Manager of the new railway.

The railway west of Callendar was being constructed in 1882; and by Fleming's advice a route close to the shore of Lake Superior was chosen, rather than one north of Lake Nipigon. In 1883 trains were running between Port Arthur and Red River. In the next year 403 miles of the route near Superior were ready, and the section was completed by May 1885. Further details of the construction are given in Chapter XIX.

Settling the Prairies, 1890 to 1910

Railway communication by way of Minnesota (and Emerson) reached Winnipeg before 1880. The whole western region as far as Vancouver was available for emigrant traffic *via* the C.P.R. by May 1887. But the great emigrant movement into the Prairies began in the 'nineties and reached a peak about 1913. It is well to remember that many of the newcomers were from across the border, so that in less than twenty years over a million Americans took up land in the Prairies. They usually had more money than the folk from Europe, and so obtained the better land near the railway, which was sold to them by the railway companies from their land grants.

About 1900 over 7,000 Doukhobors settled in the northern 'Park Belt' of Saskatchewan. They are of Russian ancestry, many of them coming from Armenia and adjacent parts of the U.S.S.R. A branch of the C.P.R. reached Edmonton by 1891, and in 1905 it was chosen as the capital of Alberta. The new northern railway reached the town about that year; and by 1908 the first settlers were penetrating the Peace River area at Grande Prairie, though the main settlement came much later.

Mackintosh, in his excellent book *Prairie Settlement* (Toronto, 1934), gives a series of ten maps which illustrate the spread of railways and of settlement in the Prairies from 1886 to 1931. Two of these for 1891 and 1911 are reproduced herewith. In the map for 1891 (Fig. 106) we see clearly the control exercised by the railways on settlement. Several branches have been constructed reaching to Edmonton, Prince Albert and Yorkton (east Saskatchewan). Sparse settlement has gone well beyond Yorkton, while the coal of Lethbridge has helped to bring a branch into this district. Other lines soon came in from U.S.A., to join the Canadian railways at Lethbridge and Estevan, as well as at Emerson south of Winnipeg.

There was not much change in the picture by 1901 except in the regions near Yorkton, Lethbridge, and Edmonton, where the belt of settlement was distinctly denser. In the next five years the wide area between Edmonton, Saskatoon, and Prince Albert was all fairly settled, though the railways shown crossing this belt in the next

map did not come into existence till a few years later. As the map shows, by 1911 all the main portion of the Prairie belt was occupied in some degree. Since that date the chief characteristics have been the development of a railway net throughout this area, and a much greater density of settlement. Only in the far north-west beyond Edmonton has there been a considerable expansion in the Peace River Area. This includes a good deal of land in Alberta around Grande Prairie, as well as the latest farmlands in the so-called 'Peace River Block' (P.R.B. in map), which is in British Columbia (Fig. 106).

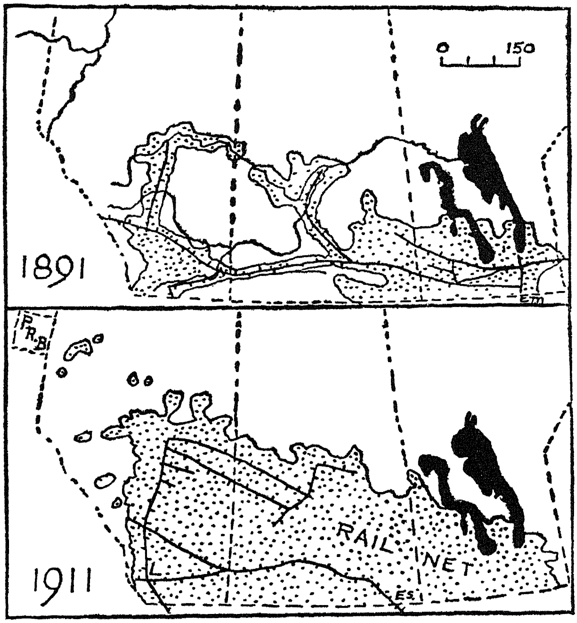


FIG. 106.—Twenty years of settlement in the Prairies. By 1911 a 'railway net' served the east. Lethbridge, Estevan, and Emerson are indicated. (Based on W. A. Mackintosh)

It is very important to realize that today the densest population in the Prairies is not along the early C.P.R.; but far north of that route in the 'Park Belt'. Here the soil and rainfall are better. Accordingly in the 1931 census those districts with more than ten people to the square mile are widespread in the vicinity of Dauphin, Yorkton, Saskatoon, Prince Albert, and especially near Edmonton. There was, however, not a single large district with this density along the C.P.R. between Winnipeg and Lethbridge in 1931.

In the ten years 1901 to 1911 the two western prairie provinces quadrupled their population; and much of this settlement resulted

from the increased knowledge of the environment. Thus in 1910 Saunders produced 'Marquis' wheat, which matures much earlier than the older breeds; and so enables farmers to grow wheat with security along the northern edge of the croplands where frosts are rather early. So also the great development of mining in British Columbia gave the prairie farmers a special market for their grain and hogs, where they had few rivals. Cattle ranching went ahead in the drier prairies after 1890, while the coal-mines near Estevan were brought into use about the same time (Fig. 60).

British Columbia and the Yukon; 1880 to 1910

The remarkable control exercised by topography on settlement can be realized by comparing the croplands of two of the provinces of the Dominion; e.g. British Columbia and Prince Edward Island.

	Area of province	1940 croplands	Percentage of area
Prince Edward Is.	2,184 sq. miles	505,000 acres	36 per cent
British Columbia	366,255 ,, ,,	520,000 ,,	0·2 ,, ,,
Alberta	255,285 ,, ,,	14,238,700 ,,	8·6 ,, ,,

Thus the little Maritime island has as much cropland as the huge western province, which is about 180 times as large. This surely suggests that there is not much unused first-class land suitable for close settlement in British Columbia. Luckily it is well endowed in regard to mines, forests, and water-supply; though it seems unlikely that it can long continue to rival Alberta in its total population: since croplands promote close settlement.

From the foregoing remarks it will readily be understood that the settlement of the most western province did not consist of the migration of farmers to vast new wheatlands. Yet the delta lands of the Fraser River contain nearly half a million people, so that this corner of the huge province has experienced a settlement not unlike that of the best parts of the prairies. However, the chief factors which must be referred to in this brief survey belong to other fields.

As early as 1890 there were seven large fish factories along the lower Fraser River, and within a few years similar operations were transferred to the Skeena River far to the north. Chinese were introduced to 'cut and can' the salmon. About the same time the suitability of the southern valleys for the growth of fruit was being recognized. Much of this fruit within a decade or so was sold to the folk on the prairies, who however in return sent grain and meat to British Columbia.

The boom in timber in the province began about 1900, and much

was exported to neighbouring countries. Some of the conifers were found to produce excellent shingles for roofing houses, and a big industry developed in these products of the forest. Perhaps in mining, however, do we find the most characteristic feature of these decades. By 1870, placer (i.e. alluvial) mining in the Caribou Mountains was nearly over. But the great granite areas of the Coast Range and of the Selkirks were found to be rich in gold, silver, copper, and other metals. The numerous mines in the Kootenay-Rossland region were first thoroughly exploited in the twenty years after 1890. Smelting furnaces were built near Nelson in 1896; and the great plants at Trail began about 1896. In 1899 the Kimberley branch of the C.P.R. linked the famous Sullivan (lead-zinc) Mine with the main line from the Crow's Nest coalfield. Today the chief traffic on this line is connected with the smelting of Sullivan ores at the great smelters of Trail close to the U.S. boundary (Fig. 65).

As the placers of the Caribou region began to be exhausted the miners explored the streams to the north. They found fair yields of gold in the Cassiar Ranges (now crossed by the Alaska Highway) in 1870. The Stikine gave gold as early as 1861, and the Omineca in 1871. Thus the miners were led still farther north to the basin of the Yukon River. Fortymile Creek was the scene of a rush between 1886 and 1895. Bonanza Creek, nearby in the famous Klondike River area, was discovered in 1896 (Fig. 138), when Fortymile was at the height of its prosperity (Howay, &c.). In July 1897 over 1½ million dollars' worth of gold was taken out of the Yukon on one ship. In March 1898 there were 7,000 men waiting for the spring thaw on Lake Bennett, which would enable them to float down-river to the digging at Klondike River. The history of this field is, however, given in another chapter of the book (p. 275).

Recent Developments in the East

For many decades the eastern portion of the Dominion has been fairly densely settled as regards the more promising portions of the area. Hence the chief changes have been in the *character* of the settlement rather than in the density. Here, as elsewhere, the shift has been on the whole from rural to industrial activities, and these are discussed at some length in the chapter on Manufactures. But there is one area in the east where a considerable amount of settlement has taken place during the twentieth century, and a brief reference to the new farms in the Clay Belt will not be out of place.

The physical description of this area, which crosses the common boundary of Ontario and Quebec, will be found on p. 217. The region waited for important settlement until the railways reached it. The C.P.R. sent a branch north from Mattawa to Lake Temiskaming

in 1877, and a little settlement occurred north of the lake. But the more important railway (from the south) reached Cochrane in 1908, and the C.N.R. crossed the belt in 1912; so that thereafter farms were rapidly taken up. By 1937 about 5 per cent of the area was occupied; chiefly between Cobalt and Cochrane, and Amos and Cochrane. According to J. R. Randall [1] there were 81,000 folk in the region by 1931.

It was during the 'nineties that the timber industry shifted its locale from the Ottawa River to such places as the upper Saguenay. Georgian Bay, Manitoulin and the 'Soo' Region were exploited for their timber about the same time. By 1912 almost half the pulpwood cut in these areas was going to U.S.A., to be ground into pulp in the American mills. Water-power was naturally exploited by these huge Canadian mills; and the rapids at Cornwall were supplying ten mills as early as 1905 (M. Q. Innis, *passim*). In 1906 the great hydro-electric resources of Niagara began to be used on a large scale. From 1883 to 1911 was the period in which the famous mines of northern Ontario were discovered. Thus Sudbury started about 1883, and by 1893 was supplying about 69 per cent of the world's nickel. Cobalt began in 1904, and Porcupine in 1910–11.

Progress in the Maritimes has been much slower than in the west. Almost all the population of the prairies has developed since 1871. Ontario and Quebec have increased about 60 per cent, but in the Maritimes only 35 per cent of the present total has been added since 1871. In Prince Edward Island the population was 94,000 in 1871, and was only 95,000 in 1941. Fish continued to be the mainstay of Nova Scotia, though fresh fish increased in importance as contrasted with dried cod after 1908. Pulp and paper have become of great importance in New Brunswick in these later decades. However, the coal resources of the Maritimes have added to their prosperity. In 1894 steelworks were erected near New Glasgow, and in 1900 the huge plant at Sydney was commenced. The iron ore comes mainly from the huge deposits at Wabana (Bell Island) in Newfoundland. Prince Edward Island has carried on intensive agriculture throughout the period. The rearing of poultry, the production of eggs and potatoes, and the spread of fox farms have characterized recent years.

In recent years the chief events in the *west* have been the building of the Alaska Highway (1942), the mining developments at Radium (Great Bear Lake) and at Yellowknife, and the oil fields at Leduc and Redwater near Edmonton. In the *east* the incorporation of Newfoundland and Labrador in the Dominion (1949), and the development of the iron mines in north-east Quebec, are equally notable. Kitimat power is described on p. 203.

[1] *Settlement of the Great Clay Belt*, Geog. Soc., Philadelphia, 1937.

CHAPTER XIV

FISHING AND THE FUR TRADE

PART I

THE CANADIAN FISHING GROUNDS

FROM a number of Government publications the following data on Canadian Fisheries have been compiled. For many years Japan has been the chief fishing nation in the world, and a few years ago the figures of the leading countries were somewhat as follows:

1. Japan	$156 million	5. France	$35 million
2. Britain	100 ,,	6. Norway	23 ,,
3. U.S.A.	92 ,,	7. Spain	20 ,,
4. Canada	52 ,,	8. Newfoundland	10 ,,

It seems likely that the fishing grounds of Canada are the largest in the world, though they have not yet been exploited so fully as in some of the other countries. On the Atlantic side the coastline from Grand Manan to Labrador measures about 5,000 miles (omitting minor bays, &c.). The Bay of Fundy, the Gulf of St. Lawrence, and allied ocean waters comprise not less than 200,000 square miles; or over four-fifths of the area of the fishing grounds of the North Atlantic. There are also some 15,000 square miles of inshore Atlantic waters controlled by Canada (Fig. 107). The Pacific coast measures 7,180 miles in length, and is characterized by some of the most intricate fiords in any continent. In addition, the Great Lakes contain more than half the fresh water of the world, of which Canada owns about 34,000 square miles, plus Lake Winnipeg and lesser lakes. The fish of the Arctic shores have not yet been studied in any detail, and no fishing of great importance has yet taken place.

In recent years the total value from all the fisheries has been about 150 million dollars. Of this vast amount the larger share comes from the Atlantic Coast, and amounts to about 70 millions. The fish of the Pacific coasts brings in about 59 millions, while the inland fisheries account for 20 million dollars.

The total value of the fish obtained in Canadian waters has not changed very greatly in the last thirty years. It was worth about 30 millions in 1912, about 40 millions in 1922 (after a maximum of 60 millions in 1918), and has varied from 45 to 75 millions in the last

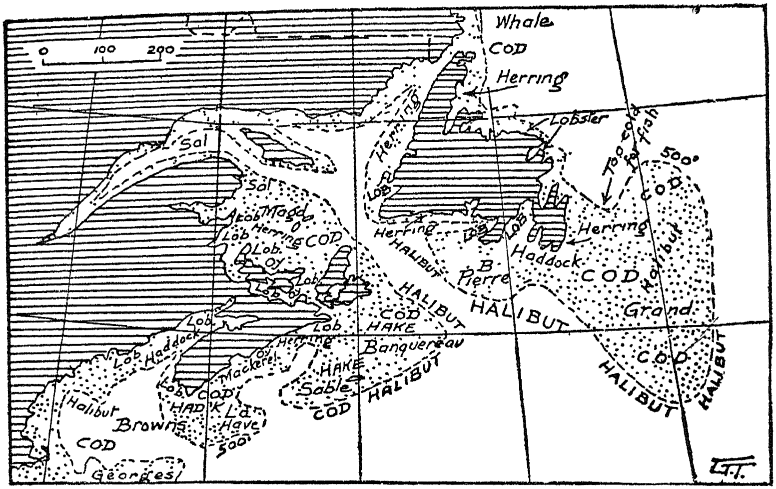


FIG. 107.—The ' Banks ' off Newfoundland and the Maritimes are shown dotted. The submarine contour of 500 feet is charted. The distribution of fish is partly based on G. A. Cornish

few years. The leading province is British Columbia, followed at a considerable interval by Nova Scotia, as the following table shows.

VALUE OF FISHERIES IN THE PROVINCES IN 1956

1. British Columbia	$67 million	6. Manitoba*	$6 million
2. Nova Scotia	49 ,,	7. Prince Edward Is.	5 ,,
3. New Brunswick	23 ,,	8. Saskatchewan*	1 ,,
4. Quebec	8 ,,	9. Alberta*	1 ,,
5. Ontario*	9 ,,		

* All fresh-water fish.

Salmon, herring, cod, and lobster are by far the most important of the fish caught; while the marine fish are worth about seven or eight times as much as those coming from inland waters.

VALUE OF VARIOUS FISH CAUGHT IN 1952

1. Salmon	$41 million	8. Pilchards	$2 million
2. Herring	10 ,,	9. Haddock	5 ,,
3. Cod	18 ,,	10. Pickerel	4 ,,
4. Lobster	18 ,,	11. Mackerel	2 ,,
5. Whitefish	7 ,,	12. Grayfish*	1 ,,
6. Halibut	7 ,,	13. Saugers†	1 ,,
7. Sardines	5 ,,	14. Trout	1 ,,

* Akin to the dogfish. † Akin to the pickerel.

Fisheries of the Dominion, Marine and Fresh Water

Some idea of the relative importance of the various industries of the Dominion can be obtained by a consideration of the following table, which shows the values of various productions for the years 1942 and 1952:

	1942	1952
Manufactures (net)	$3,310 million	$7,433 million
Value of crops	1,179 "	1,771 "
Livestock and dairy	1,172 "	2,217 "
Mineral products	566 "	1,285 "
Forest products	213 "	815 "
Fisheries	75 "	150 "
Fur trade	10 "	23 "

Hence it is obvious that there has been a tremendous shift in relative values from the early days of the Dominion, when fur and fish were the chief natural resources.

Some account of the early cod fishery is given in previous chapters (p. 307). After the coming of the Loyalists from the United States, fishing villages grew up all along the Atlantic coast, but those engaged in the industry on the more northern coasts continued to be almost exclusively French. Certain advantages as regards fishing rights are still held by U.S.A. in the waters off the Canadian coasts. (*Handbook of Canada*, Toronto, 1924, to which the writer is much indebted.)

The fisheries of the Dominion may be considered under three heads based on the waters concerned: the Atlantic fishery; the Pacific fishery; and inland fishery. As regards fish taken from the Atlantic Ocean there are two distinct areas involved: the deep-sea or 'bank' fisheries, and the inshore fisheries.

Some of the geographical data of the 'banks' are discussed and illustrated in the section on Newfoundland (Fig. 76). A. G. Huntsman has given a good account of the oceanography of the Atlantic near Nova Scotia in the above-mentioned book.

The submerged portion of the continent forms a shelf one hundred miles or more in width, culminating in the Grand Bank with an area of 40,000 square miles. From Cape Cod northwards these banks are known as George's, Brown's, La Have, Sable Island, Banquereau, St. Pierre, Green, and Grand Banks (Fig. 107.) These are covered with less than fifty fathoms of water, and the banks are divided by deep channels or submarine canyons, whose origin is somewhat of a puzzle. In the open Atlantic the *tropic* water with a temperature of about 59° F. and a salinity of over 35 per mille presses constantly northward. Beneath the tropic water, which has a thickness of several hundred fathoms, a heavier *bottom* water moves slowly towards the south. It has a temperature of about 39° F. and a salinity of from 34 to 35 per mille. This water is returning to the equator; and, owing to the deflection due to the earth's rotation, it is massed against the American side. There

is a definite vertical line of demarcation between the cold northern currents and the tropic currents, and these different bodies of water are sometimes known as the 'Cold Wall', and the 'Gulf Stream'.

It has been found that there are three layers of water in the Gulf of St. Lawrence. The *deep* layer has a temperature of 41° F. The middle layer or '*bank*' water has a temperature below 32° F., and the low salinity of 32 per mille. The *surface* water in the summer attains a temperature of 59° F., and owing to the influx of river water its salinity may be only 30 per mille. Huntsman states that the Canadian fishing waters are something like those of Scotland and Norway as regards temperatures, but they are quite dissimilar in salinities.

The dominant fauna of the region would be classed as *boreal*; and the majority of them occur south of Cape Cod only as winter migrants, and north of Newfoundland only as summer migrants. Some of the commoner forms are the cod, herring, haddock, lobster, and soft clam. The layer of Arctic water enables many northern forms to reach the Gulf of St. Lawrence or even farther south. Thus the white whale, the harp seal and the hooded seal reach almost to Sable Island, and the walrus may reach the coast of Newfoundland, as occasionally does the polar bear. The *tropic* waters occasionally move near to the Grand Bank, bringing unusual fish such as the sunfish, flying fish, blue shark, sea horse and swordfish to the areas of the Canadian fishermen.

Until relatively recently the fishing on the banks was carried out in sailing vessels of 60 to 100 tons, carrying crews of twelve to twenty men. Each large boat uses small 'dories', from which the actual fishing is done by means of trawls or baited long-lines. The daily catches are taken to the large vessel to be split and salted down. In recent years steam trawlers, like those used in Europe, have become quite common; and they drag a huge bag-net (the otter-trawl) over the sea floor. Many fish today are packed in ice, and brought to the shore in Nova Scotia or New England in a fresh state.

All kinds of fish frequent these seas, but they can be divided into *ground* fish, such as the cod, haddock, halibut, hake, and flounder; and *school* fish, such as the mackerel, shad, and herring. The former feed on or near the bottom, while the latter swim in clusters (or schools), and feed mainly on the plankton floating near the surface. Obviously different methods are needed to catch these 'school' fish; and when the mackerel are sighted, they are surrounded by a fine-mesh net called a *seine*.

The cod is the chief fish taken in Atlantic waters, though the humble lobster rivals it in the value of the catch in recent years. The cod (*Gadus*) inhabits water from 25 to 50 fathoms deep, where it feeds close to the bottom. The fish usually measure about 3 feet in length, and weigh from 12 to 20 pounds; but H. A. Innis in his lengthy study [1] mentions a specimen which was over 6 feet in length

[1] *The Cod Fisheries*, Yale University Press, 1940.

and weighed 211 pounds. This was caught off the Massachusetts coast in 1895.

Mollusks are said to be the chief diet in the Gulf of Maine, but to the north, herring, capelin (a small sub-Arctic fish), and squid are largely devoured. With the retreat of the ice in spring, the cod follows the capelin north during June, July, and August, along the coasts of Labrador. The squid seem to appear later in the season than the capelin. The *haddock* is a close relative of the cod, and differs mainly in the character of the fins and the colour. The *hake* belongs to a closely allied genus, but the flesh is not so popular as that of the cod and haddock. Halibut (*Hippoglossus*) is quite different from the three preceding fishes. It is the largest of the flat-fishes, and may grow to a length of 10 feet. It is more important in the Pacific areas.

The best account of the geography of these fishing grounds known to the writer is a small book, *North Atlantic Fishing Grounds*, by Albert Close, published at Ilford, England. It reproduces Admiralty charts of the banks, with data as to the abundance of fish to be expected at each site. The food of the cod, seasons of fishing, temperatures of the various currents, the so-called 'Dawson Isothermal' layer of cold water off Quebec—between 30 and 60 fathoms, with halibut at 140 fathoms *below* this layer—are all topics discussed in this booklet.

Technique of the Cod Fishing Industry

A good account of this important industry will be found in the book by R. F. Grant, *The Canadian Atlantic Fishery*, Toronto, 1934. The fishing season in the 'bank' cod fishery extends from about March 15th to the end of September, during which time three voyages are usually made. The first trip fishes on the banks not far from the shore, and the second trip terminates early in June. The third trip follows at once, and the boats return late in September. From Lunenburg (Nova Scotia) the schooners average about 135 tons; and in recent years they are usually equipped with auxiliary Diesel engines.

The older style of fishing employed a long ground-line, to which short additions carrying the hooks are attached every yard or so. A complete set of such hooked lines, together with the seven or eight dories (small boats) carried by a schooner, covers a circular area with a radius of about one mile from the schooner.

After the fish are brought on the schooner from the dories, they are split, cleaned of entrails, and then stripped of the bone. The fish are now placed in layers and heavily salted between each layer. When the shore is reached, the fish are washed, and dried in the open air on *flakes*. The latter are sometimes made of wire-netting

and are open shelves usually about 30 inches above ground.' The best fish are produced by sunshine and by drying at low temperatures in spring or fall (R. F. Grant).

With the change from sail to steam, we find a corresponding change in the technique of preparing the fish. A small trade in fresh fish began from Canso (Nova Scotia) about 1890; and cod, haddock, and mackerel were the fish most affected. By 1915 boneless cod was being sold in Canada. New vessels, based on those in use in Europe, were introduced about 1910. In 1926 there were eleven steel trawlers operating; but at present Halifax is the only trawler base in eastern Canada.[1]

The modern trawler is about 250 tons weight, and about 115 feet long. It drags the otter trawl by steel ropes along the sea bottom. This trawl is a net bag, with an opening 150 feet wide, the lower margin of the mouth is weighted with lead, and the upper buoyed with floats; the trawl being lifted every hour or so. The fish are now kept in good condition by the use of ice, and in some of the larger vessels refrigerating machinery is installed. Today the fish are often filleted as soon as the shore is reached; the fillets are wrapped and then carried in refrigerated railway-cars all over the American continent. (For Newfoundland, see p. 233.)

The Lobster Fishery in the Atlantic

The canning of lobsters, salmon, and allied products began in America about 1815, when Thomas Kensett packed these delicacies in a factory near the Battery in New York. Lobsters were packed in glass jars in 1836 in Boston. The canning process seems to have started in Liverpool, Nova Scotia, in 1841. However, not much was accomplished in Canada until the 'sixties when a factory was built near Halifax; and by 1872 there were 44 lobster canneries in Canada. By 1895 all canning had ceased in the States, but the number of Canadian canneries had grown to nearly 650, and to 900 in 1900. The number diminished in later years; and in 1933 the canneries were distributed as follows: New Brunswick, 108; Nova Scotia, 107; Prince Edward Island, 91; and Quebec, 51.[2]

At the outset lobsters were caught along the American coasts by spearing them among the rocks in shallow water. Much of it was done by torchlight on calm evenings. Hoop nets were made from the rims of discarded cart-wheels, and bait fastened in the middle of the net. This type of fishing was in vogue as late as 1910 along

[1] For a well-illustrated account of trawling on the 'banks' see *Canad. Geog. Jnl.* for March 1936.

[2] *Historical Account of Lobster Canning*, R. H. Williams, Fisheries Department, Ottawa, 1930.

the Gaspé coast. The lobster-trap made of laths was in use off Cape Cod as early as 1810, but for a long time the Canadians preferred the type of creel modelled on those from England. The trap (or creel) is usually baited with herring or cod-heads, &c.

About 1872 the first shipments of live lobsters from Nova Scotia to Boston were made by Captain Crowell. In 1875 smacks were furnished with wells in which live lobsters were transported to the ' pounds ' in Maine, where they were kept alive till they were required. In 1905 about a thousand live lobsters were carried from Halifax to Vancouver, and set free in the waters of the Pacific coast.

As the methods of fishing for cod changed, demanding more and more capital for larger vessels and for expensive otter-trawls, &c., the poor fisherman was driven out of the trade to a large extent. He turned more and more to the inshore fisheries, of which lobsters soon furnished the largest sale. By the end of the century this fishery surpassed the cod fishery in Nova Scotia (H. A. Innis, *loc. cit.*). But the peak of the catch seems to have been about 1900, so that in 1928 it could be said that about three times the number of traps was needed to capture the same weight of lobster as could be taken in 1918. In Nova Scotia the number of one-pound cans declined from 5,263,780 in 1900 to 1,959,888 in 1924. In 1934 Canada exported 97,485 hundredweight of fresh lobsters to the United States; and 52,938 hundredweight of canned lobsters of a value of 2½ million dollars, of which about one-half went to the United Kingdom.

The American lobster (*Homarus americana*) does not differ much from the European species found on the Atlantic coasts of Norway, France, and Spain. The European species rarely reaches a weight of 10 pounds, but in America there are authentic records of specimens up to 23 pounds in weight. The general distribution is indicated on the map in Fig. 107. Lobsters are relatively plentiful in the shallow waters near the coast, all the way from Gaspé around Nova Scotia to Cape Cod. They are also fairly plentiful on the coasts of Newfoundland, especially in Placentia and Fortune Bays in the south-east of the island. In 1894 large catches were made along the north-west coast and in Bonavista Bay, but these areas are sadly depleted today.[1]

R. F. Grant, in her book *The Atlantic Fishery*, gives an interesting table showing how the lobster fishery varied along the coasts of Nova Scotia in 1931. The chief features appear in the following table.

[1] Two interesting maps showing lobster grounds in 1894 and in 1936 are given in *Research Bulletin No. 11*, by W. Templeman, Dept. of Nat. Res.; St. John's, 1941. See also *Pêche et Chasse*, Montreal, 1946.

1. Shelburne	$442,967	5. Guysborough	$323,692
2. Pictou	412,984	6. Cumberland	188,940
3. Halifax	357,285	7. Cape Breton	146,527
4. Yarmouth	348,899	8. Inverness	113,622

The Fisheries of the Pacific Coast

For many years the fisheries of British Columbia have represented about half of the total product of the Dominion. The cod of the Atlantic and the salmon of the Pacific were rivals for first place in the earlier years of the fishing industry; but since 1895 salmon has definitely taken the lead, with lobster (from the Atlantic) in second place. However, in 1942 herring, with an exceptionally large catch, took second place in order of marketed value, and cod was third.

On the Pacific coast since about 1890 the deep-sea fisheries have become of considerable importance, though salmon from the rivers is still by far the chief product. Here as in the case of the Atlantic the ocean currents are of great importance, for the Japanese current sweeps to the eastward along the 50th parallel until it reaches the continental shelf, where one branch sweeps north, while the other turns south as the California Current, and forms a settled drift about 55 miles west of the Vancouver Island shore.[1] It seems likely that it was the ease with which the salmon, &c., were caught in the estuaries of the large rivers, that delayed the exploitation of the deep-sea fisheries.

The Pacific coast salmon belongs to the genus *Oncho-rhyncus* (or hook-nose fishes), and differs somewhat from the true *Salmo* of Europe. There are five species of Pacific salmon, which ascend the rivers between the months of April and December in great numbers, in some cases travelling 2,000 miles from the ocean. In the Pacific rivers none of the salmon returns, but when breeding is completed the fish soon die, while the young migrate to the ocean when they are over a year old. The value of the salmon pack even in 1911 was nearly 10 million dollars, but in recent years it has reached double that figure.

Of the five species the *Sockeye* is the best known, and its run up the Fraser River has in the past been marked by a pronounced cycle of four years, one very good year being followed by three poor years. The sockeye weighs from 3 to 4 pounds, though specimens up to 17 pounds have been taken. The main run in the Fraser takes place in the months of July and August, and the spawning occurs in lake-fed streams. The *Quinnat* or spring salmon weighs from 18 to 30 pounds, and its colour is darker than that of the sockeye. This fish enters the Fraser, the Nass, and the Skeena, early in the

[1] D. N. McIntyre, *Canada and its Provinces*, Toronto, 1914.

spring. The *Coho* is a smaller variety, and the runs take place in August in the north, and in September in the Fraser.

The first cannery was built in 1876 near New Westminster, though plants had been erected in 1864 on the Sacramento River in U.S.A. In 1877 there were five canneries on the Fraser, and one was opened on the Skeena. In 1883 canneries were opened on the Nass, and also in many parts of the waters of Puget Sound. Today the fisheries of British Columbia are worth 38 million dollars.

The chief Canadian centre for the halibut fishery is Prince Rupert, which is second only to Seattle, U.S.A., in this respect. The favoured areas are where there are shallow waters of the proper temperature; and these are found along much of the coast north of Vancouver Island as far as Shumagin Islands off Alaska Peninsula.[1] Great banks to the west of Cape Spencer (near Juneau) have been exploited lately. Cold-storage facilities at Prince Rupert, Ketchikan, Wrangell, and Juneau have greatly improved the conditions of the industry.

In recent years the fish have been taken on long lines carrying short attached lines with the bait. The halibut feeds near rough ground, where nets are not readily used. In the last twenty years the use of the more economical and safer Diesel engine has helped the fisherman materially. Japanese halibut from the coasts of Siberia can be sold cheaper than the American catch, and this has lessened the profits of the industry. Haddock is to some extent replacing halibut because it is a somewhat cheaper fish; but the large amount of vitamin-rich oil obtained from the halibut gives it a special value as an article of food.

There are a number of other valuable food fishes found in Pacific waters such as the herring (*Clupea*), which occurs in dense schools off Nanaimo and the Queen Charlotte Islands. These fish have not yet been properly exploited as a source of food for Canada.[2] In former days there was a good deal of whaling done off British Columbia, and some decades ago there were two stations on Vancouver Island and two on the Queen Charlotte Islands. The Sulphur-bottom whale (*Sibbaldius*) is the commonest whale, but the hump-back and right whale (*Balaena*) were also harpooned. In 1920 493 whales were taken in British Columbian waters.

The Inland Fisheries

The Great Lakes and the tributaries of the St. Lawrence, together with the rivers of the Mackenzie basin, are important producers of

[1] 'Halibut Fishery', by J. Q. Adams, *Economic Geography*, Worcester, Mass.

[2] For a good account of the pilchard and herring fisheries, and the oils derived from them, see the article by N. M. Carter in *Canad. Geog. Jnl.*, December 1937.

fresh-water fish. The chief types caught are whitefish and trout, which account for about half the catch. But there are also large numbers of perch, tullibee (akin to the herring), pickerel, pike, and fresh-water herring. These are obtained in large numbers in Ontario waters, while eel and pickerel are perhaps the chief of the Quebec fresh-water fish.

The season in the Great Lakes lasts from six to eight months, and whitefish and pickerel are the chief products of the prairie lakes. Some notes on the fish of the Great Slave Lake are taken from a recent report of the Fisheries Board, Ottawa, 1945. This lake has an area of 10,500 square miles, and varies a good deal in depth. The north and west arms are from 100 to 500 feet deep, but the east arms in the Shield are much deeper, 1,440 feet having been recorded. The temperature of the surface water is usually about 57° F., but in shallow water in summer the temperature rises to 63° F., though in the deeper water it is around 40° F. Diatoms, *Melosira*, and copepods form the chief plankton fauna.

Gill nets are used in all parts of the lake, and whitefish and lake trout are the commonest species here. Grayling is abundant near the rocky shores, while ' inconnu ', pike, and other coarse fish are chiefly of value for dog food. Lake Athabasca with an area of 3,000 square miles has been producing more than 1 million pounds of whitefish and trout per annum. Great Slave Lake has much the same conditions, and should be able to produce three times this amount. Probably about 1 million pounds of whitefish and coarse fish are caught annually, and are nearly all used by the Indian trappers to feed their sledge dogs. Dogs need about 2 pounds a day in the summer, and about 9 pounds when working in the winter. Such fish must be caught in the season from June to October, and in these months all the Indians and many white trappers spend most of their time catching food for their dogs. The fish is dried and smoked for winter feed.

PART II

THE FUR TRADE IN CANADA IN MODERN TIMES

Later History

In Chapter II, dealing with the exploration of the interior of the Dominion, a fairly full account is given of the development of the fur trade from the early days of Champlain to the amalgamation of the North-West Company with the Hudson's Bay Company in 1821. The standard authority on the history of the whole industry is H. A. Innis, whose large book *The Fur Trade in Canada* (Yale Uni-

versity) appeared in 1930. Some extracts from this volume will carry the reader from the early days of 1821 to modern times. The rivalry between the company and the prairie farmer has already been referred to on p. 319.

In the 'sixties a cargo from England to York Factory on Hudson Bay would amount to 60 tons; and would contain guns, ammunition, tea, sugar, tobacco, rum, axes, and other tools, cooking utensils, blankets, and clothing. Not only were the valuable furs exported by the company, but they were interested in the sale of many other products of the region. Innis mentions a list given by R. M. Ballantyne about this time as including: beaver, bear, badger, buffalo, deer-skins, goose-skins, fox, ivory, lynx, marten, musquash

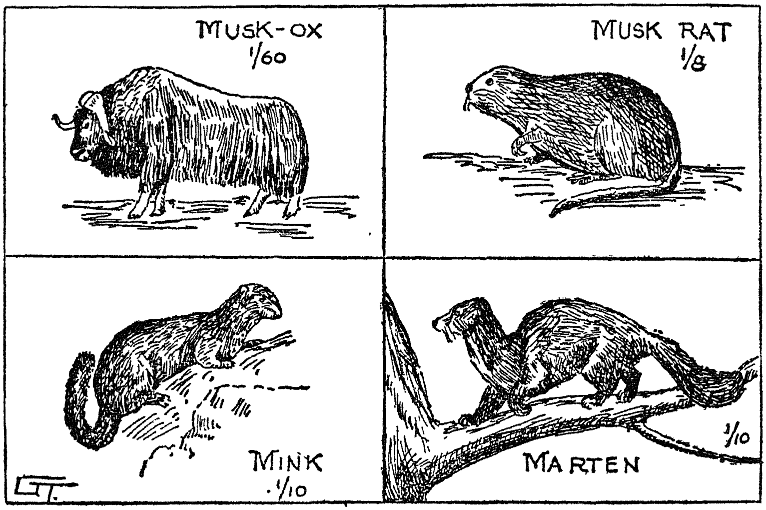


FIG. 108.—Sketches of four important fur-producing mammals of Canada

(i.e. muskrat), otter, seal, and whale oil, seal fur, salmon, wolf-skins, and wolverine-skins (Fig. 108). In 1857 the company employed 16 chief factors, 29 chief traders, 5 surgeons, 87 clerks, 67 postmasters, 1,200 permanent servants, 500 voyageurs, and 150 officers and crews of vessels.

The numbers of beaver soon began to decline with the onslaught by Indians and others using the improved weapons of the white man; and the Company found it necessary to restrict the taking of fur. In 1826 the numbers allowed to be trapped were as follows: Athabasca, 5,000; Saskatchewan, 5,500; English River, 650; Cumberland, 150; Swan River, 400; Winnipeg, 50; Norway House, 120; Nelson River, 400; Churchill, 300. The company was soon menaced by the free-trader, who was threatening the Nelson River

district by 1862. Another trouble arose from the change from beaver hats to silk hats, which began about 1840, and resulted in less demand for the fur of the beaver.

The important changes in communications during the 'seventies and 'eighties naturally much affected the fur trade. Goods ceased to be sent through York Factory after 1875, for Fort Garry (Winnipeg) was now becoming the chief entrepôt for the whole west. In 1874 a steamer was placed on the Saskatchewan above the Grand Rapids (where the river enters Lake Winnipeg). The main route north by land was from Edmonton to Athabasca Landing on the river of that name. Goods for New Caledonia (British Columbia) were portaged in 1879 to the Peace River basin, by oxen kept for that purpose near Little Slave Lake (Innis, *passim*). Portage La Loche was first crossed by Peter Pond in 1778, and became one of the chief corridors of the interior. It lies about 80 miles up the Clearwater River from McMurray, and the 12-mile portage linked the upper Churchill with the Athabasca-Mackenzie basin. Some sketches illustrating transport of the furs, after the road was built in 1875 on this route, are given in Fig. 109. They are drawn by S. Ells.

In 1885 the first steamer, the *Wrigley*, was built on the Slave River north of the long rapids at Fort Smith. It was now possible to serve much of the great Athabasca-Mackenzie basin by this steamer, and many more were soon built. The railway reached Athabasca Landing in 1916; and another line reached Waterways on the Clearwater in 1920. After this date the latter place became the chief port for goods entering the north-west. Some of the last posts established by the famous company in the far north are: Bernard Harbour 1916, Cambridge Bay 1921, King William Land 1923, and Fort Hearne 1928.

Growth of the Fur Trade

An excellent account of the fur trade is given in a publication by the Department of the Interior in 1924 (*Handbook of Canada*). This points out that for centuries the beaver was the fit emblem of the fur trade. Its pelt was used as a peace offering by the Indians, and gifts to the early missionaries enabled them to develop their missions to the Indians. In 1650 the trade at Tadoussac resulted in 40,000 livres profit, and 100 canoes laden with beaver came yearly to this post. In 1788 the trade of the North-West Company amounted to $200,000; and by 1799 it had grown to $600,000, based primarily on 106,000 beaver pelts. For the years 1853 to 1877, the Hudson's Bay Company sold about 3 million skins in the London fur market.

The sea otter is the most valuable of the fur-bearers, and was once plentiful. It was taken in thousands on the Pacific coast between

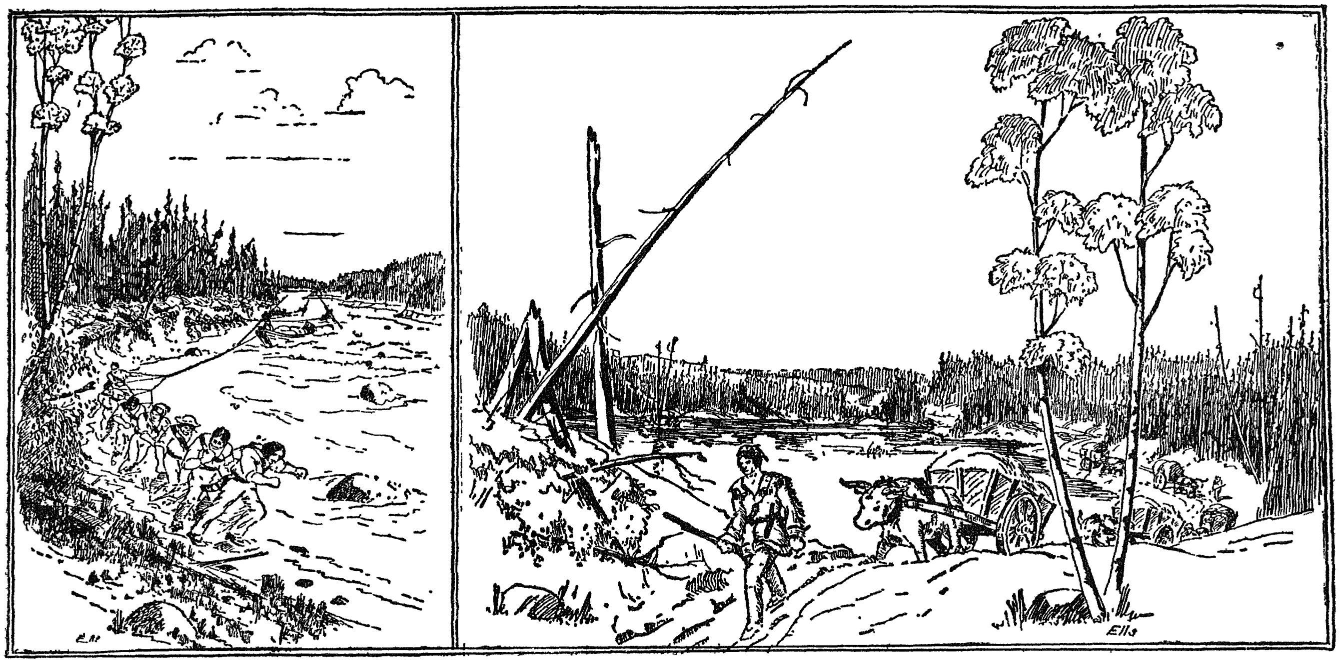


FIG. 109.—Two sketches by S. C. Ells illustrating former transport in the fur trade. The left-hand sketch shows two 40-foot York boats being hauled up-river by track-lines. The right-hand sketch shows a train of Red River carts on the portage at La Loche Lake. (From *Canad. Geog. Jnl.*, 1936)

1750 and 1875; and was eagerly bought by Chinese and Russian aristocrats. Indeed, in China a wealthy man would give $200 for a single skin. It was this fur-bearer which led to the first occupation of the Bering Sea Islands and Alaska by Russia. While at Nootka Sound, Captain Cook in 1778 is said to have bought 1,500 for sixpence apiece. However, owing to reckless killing these beautiful animals are practically extinct.

Another marine mammal with a valuable fur is the seal, of which there were said to be 4 millions in the Bering region in 1847. These were reduced to 200,000 by the year 1910; and steps were then taken to ensure that they should not be exterminated like the sea otters. Commercial killing on the chief seal resorts (Pribylov Isles) in the Bering Sea was prohibited between 1910 and 1918, and they are now protected from undue slaughter.

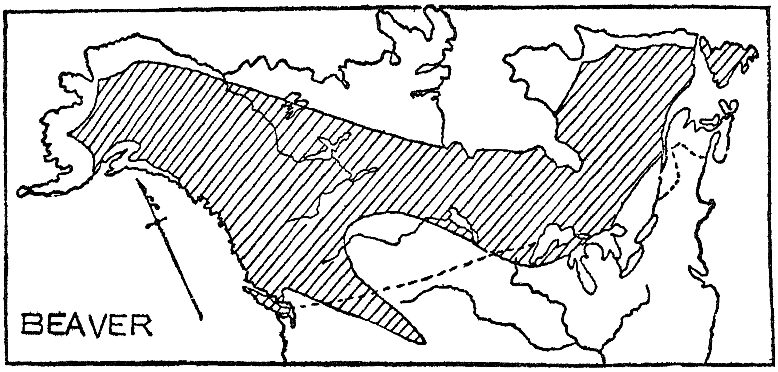


FIG. 110.—The habitat of the Beaver (after Thompson Seton)

Increase in trapping and improved methods of capture, together with the advance of settlement, have driven fur-bearing animals farther and farther afield; and to conserve the fur resources it has been necessary to provide for closed seasons during certain periods of each year. Common and previously despised furs are now becoming popular; and fur-farming is playing an increasing part in the trade. In 1850 the value of raw furs exported was about 94,000 dollars, and during the last twenty years the value has been rather steadily increasing, from 10 million dollars in 1921 to 25 million dollars in 1942.

In the early years of the nineteenth century the export of furs from Canada exceeded in value those of any other product. The total output has not seriously declined, and Canada may still be regarded as possessing in her northern regions one of the great fur preserves of the world. The fur-bearers are mostly carnivorous animals, but two very valuable rodents are included, namely the beaver and the muskrat (Fig. 110).

The largest fur-bearing animal is the bear ; polar along the Arctic coast and Hudson Bay, grizzly in the Rocky Mountains, and black (or brown) common in wooded areas generally. Wolves—grey, black, and blue are colour varieties—are common and widespread. Indeed, they have been killed in recent winters within 50 miles of Toronto. Fox pelts account for a very large part of the fur trade, though muskrat is perhaps the most numerous pelt today.[1] The ermine or weasel is fairly plentiful throughout the Dominion, and

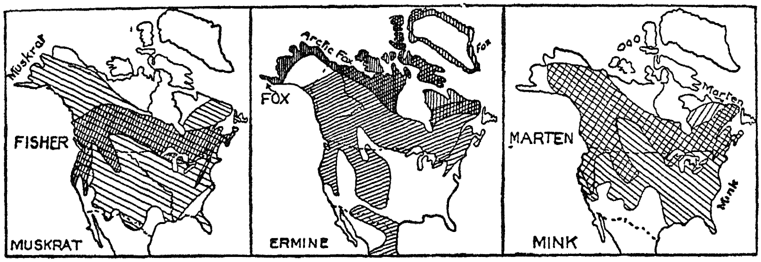


FIG. 111.—Habitats of six of the chief fur-bearing mammals of Canada. (Based on maps by Thompson Seton)

is found as far north as trappers are operating (Fig. 111). Otter, beaver, marten, fisher, and mink are furs of exceptional quality and beauty, and are secured throughout the whole of the timbered parts of the northern belt (*Yearbook* for 1942).

The importance of the fur trade can best be gauged from the following tables, showing the numbers of pelts obtained from the various animals, and the provinces which are most concerned in the trade :

1957		1932–3		
Animal	Value	Animal	Value	Pelts
1. Mink	$16,850,000	1. Silver fox	$3,135,885	102,706
2. Muskrat	3,177,000	2. Muskrat	1,581,606	2,731,490
3. Beaver	3,200,000	3. Mink	1,438,375	168,592
4. White fox	461,000	4. Beaver	698,660	71,699
5. Ermine	372,000	5. White fox	682,959	33,385
6. Otter	358,000	6. Cross fox	502,385	19,658
7. Fisher	97,000	7. Ermine	402,517	743,159
8. Marten	81,000	8. Marten	319,278	23,725
9. Lynx	75,000	9. Lynx	208,681	11,932
10. Fox	75,000			
11. Rabbit	64,000			
12. Raccoon	54,000			

[1] My colleague, Professor J. R. Dymond, kindly obtained for me the two maps illustrating the range of the fur mammals.

The total value of furs has not changed from $24 million in the last decade (1957). But mink has moved to first place with 16 million dollars' worth, followed by muskrat (3·7). Silver fox and white fox have dropped to some half million dollars each, while beaver advanced in value to 3·3 million. Squirrel, marten, and ermine have declined somewhat in value from 1942.

DISTRIBUTION OF FUR IN PROVINCES, 1957

1. Manitoba	$5,980,000	7. N.W. Territories	$732,000
2. Ontario	5,562,000	8. Nova Scotia	665,000
3. British Columbia	3,577,000	9. New Brunswick	285,000
4. Alberta	3,383,000	10. Newfoundland	256,000
5. Saskatchewan	2,991,000	11. Yukon	109,000
6. Quebec	1,970,000	12. Prince Edward Is.	76,000

The Fox-Farming Industry

The relatively high position of tiny Prince Edward Island in the above table, which produces half as much wealth from furs as the giant 'pioneer' province of British Columbia, is to be explained by the rise of the fox-farm in the Maritime provinces. In the early days trappers caught animals in the summer, when their furs were in poor condition, and fed them for some months until the fur became thicker and more valuable. In 1894 two farmers in Prince Edward Island started to experiment with various varieties of fox, and soon obtained black and silver puppies. In 1910 twenty-five of these pelts were sold in London at an average price of $1,339; and this naturally started a fox-farming boom (*Canadian Year Book*, 1942). The 4,049 farms in 1949 have dropped to 2,518.

In 1915 a Silver-Fox Breeders' Association was formed to register pure-bred foxes, and the foundation of the silver-fox industry was assured. In 1920 the first fur auctions were held in Montreal, but the chief outlet, until the recent war started, was to London. The growth of this interesting new industry, especially in New Brunswick, is illustrated by the table on p. 354.

There have been many changes in the fashions, which makes matters rather difficult for the 'farmers'. Black fox was popular thirty years ago, and since then 'half silvers', 'full silvers', and new types have been commanding the higher prices. In recent years the breeders in the U.S.A. have evolved a heavily furred pale-silver fox of a new type; and hundreds of ranches stocked with this type have sprung up in U.S.A. In the last decade there has been a regrettable tendency to produce quantity rather than quality, with the result that there has been a lowering of prices of all grades of furs. The average price for the pelts produced in Canadian farms has

Province	Silver-fox pelts	
	1920	1938
Prince Edward Island	2,982	70,420
Nova Scotia	517	29,616
Quebec	348	55,203
Alberta	200	26,142
Saskatchewan	172	17,703
New Brunswick	166	60,020
Ontario	148	38,234
Manitoba	127	18,734
British Columbia	123	3,328
Yukon	137	78
North-West Territories	59	215
Canada	4,979	319,693

been steadily dropping from $104 in 1928 to $15 in 1939. Prime pelts today of the best type fetch about $70, while dark low-grade pelts are worth only $11 or less. A new white-nosed 'platina' fur has been evolved in Norway, and these pelts have fetched astounding prices. Thus a single specimen in New York in 1940 was sold for $11,000. Today Canada and U.S.A. rank about equal in the market, with about 260,000 skins; but Norway produces about twice as many, and leads the world in fox-farming.

Many other fur-bearing animals besides foxes are bred on the Canadian farms as the following table shows:

VALUE OF FURS RAISED ON FARMS IN 1956

1. Pastel Mink	$5,392,000	5. Fox	$29,000
2. Other Mink	4,715,000	6. Chinchilla	26,000
3. Standard Mink	3,438,000	7. Other pelts	2,000
4. Platina Mink	1,837,000		

The Preservation of the Buffalo, Reindeer, and Musk Oxen

It is only in comparatively recent years that the problem of conserving the game resources of the north has become a matter of serious attention. The buffalo of the great plains has only just escaped total extinction, and the same thing is true of the northern woods buffalo. Luckily measures have been taken in time to avert this fate from the reindeer (caribou) and the musk oxen. Various accounts of the measures adopted can be found in the publications of the Department of Mines and Resources, Ottawa. Two of the

most interesting are *The North-West Territories*, 1930; and *Canada's Western Northland*, 1937. (See also J. L. Robinson, *C.G.J.*, Jan. 1946.)

The Buffalo (*Bison athabascae*), which had made the northern woods of the continent their habitat, had a better chance of survival than had those who kept to the open plains on the borders of Canada and U.S.A. In 1867 a single consignment of robes (i.e. buffalo hides), sent by the Hudson's Bay Company to New York, amounted to 700 bales. Thousands of buffalo were seen on the plains near Calgary in 1875, yet they had almost vanished by 1881. The last band, said to have been no more than six, was shot in 1886 on the Red Deer River of Alberta (A. Morton, *loc. cit.*). Probably the

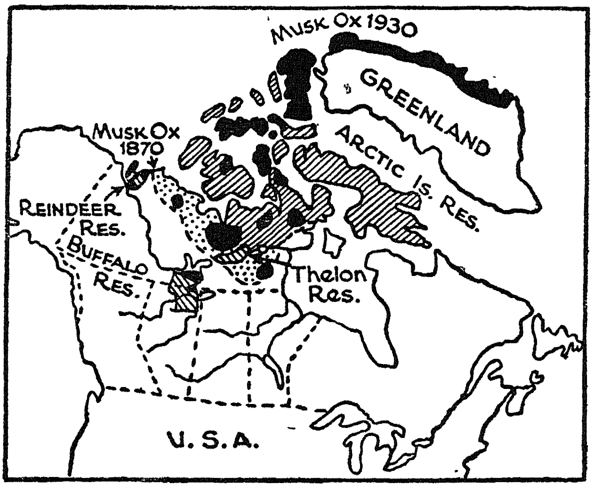


FIG. 112.—Government Reserves for the Musk Ox, Reindeer, and Woods-Buffalo in northern Canada. The present range of the Musk Ox is shown black. The heavy broken line shows the southern boundary in 1870. The 'Arctic Islands Game Preserve' is shown by diagonal lines

'big snow winter' of 1880 killed off vast numbers, and the hunters for robes finished the destruction in a few years.

The Wood Buffalo, however, survived in the vicinity of the Great Slave Lake; and in 1920 a survey was made, and about 1,500 animals were found ranging the thick coniferous woods. In this region there are numerous sandy ridges carrying lighter woods of poplar and jack pine. Coarse grasses flourish on the low-lying lands, and pea-vines, mosses, and herbage, on the uplands. There are a number of saline springs also in this region; and in the fly season the animals love to wallow in the loose sand of the ridges. In 1922 the Dominion Government set apart 10,500 square miles as the 'Wood Buffalo Park' to the south-west of the Great Slave Lake,

and this area is clearly shown in Fig. 112. Later this reserve was extended to include a large area in Alberta near Lake Claire; so that the park now includes 17,300 square miles, and is the largest big-game preserve in North America.

In 1907 the Government purchased 709 buffaloes from the herd of Michael Pablo of Montana, and these were found to thrive in a reserve near Wainwright, Alberta. In 1925 they had grown so numerous that it was decided to remove 6,673 animals to the Wood Buffalo Park. By 1940 they had become a herd of about 10,000 animals. The headquarters for the park is about 25 miles south of Fitzgerald on the Slave River. A survey by J. D. Soper shows that there are 46 species of mammals and 216 species of birds in or near the park. Among the former are moose, mule-deer, and black bear, as well as smaller mammals such as fox, lynx, mink, muskrat, beaver, weasel, hare, and skunk. Soper is of the opinion that the hare and the lynx exhibit a natural cycle of abundance of some nine years. Dr. Raup has studied the botany of the park, and finds a total number of 461 different plants.

Caribou is the American name for the genus of deer whose scientific name is *Rangifer.* In Europe the same animal is called the reindeer, and it differs from other deer because there are antlers in both sexes. In Canada there are distinct differences between the 'barren-ground' caribou, which is a smaller animal with immense antlers, and the 'woodland' caribou, which is larger but has smaller more massive antlers. The Scandinavian type seems to be more like the barren-ground species in Canada.

In Canada, the barren-ground caribou migrate to the south in the fall, and to the north in the spring. They try to reach the summer grazing grounds before the fawning season, which is towards the end of May. An extensive survey was begun in 1934, which reveals that the summer range of the deer includes the whole of Keewatin. The main herds seem to graze in the Tundra near Back River and the Thelon Game Sanctuary (Fig. 112). In 1933 they seemed to occupy the following three areas for the winter: Yellowknife area to the north of Great Slave Lake; the area between Great Slave Lake and Lake Athabasca; and many widely scattered individuals in southern Keewatin and adjacent Manitoba.[1]

It has long seemed probable that a new industry for the Eskimos might be developed based on reindeer herding; which occupies so many primitive folk in northern Europe and Asia. In 1919–29 various experts were investigating the possibilities of this new development; with the result that an extensive migration of caribou was authorized in 1928. In 1929 A. E. Porsild went to Alaska, and

[1] See the interesting illustrated article by J. G. Wright in the *Canadian Geographical Journal*, October 1944.

selected more than 3,000 reindeer from animals which were grazing there in the Buckland valley. A Lapland herder was put in charge of the herd, and for more than five years these reindeer were slowly moving eastward towards the mouth of the Mackenzie River. In March 1935 they arrived, and the total amounted to 2,370 animals.

The Reindeer Reserve consists of Richards Island in the delta, and the adjacent lakeland tundra to the east near the Caribou Mountains (Fig. 93). Some description of this area will be found on p. 284. By May 1937 there was a fawn increase for the year of about 1,000 head. A number of Eskimo youths are being trained as apprentice reindeer herders.

The most interesting animal in the north of Canada is the musk ox, whose range today is shown by the black patches on the map in Fig. 112. It is found in the far north of Ellesmere Land, as well as in the most northern parts of Greenland, i.e. in latitude 83° N. The full-grown musk ox weighs about 600 pounds, and stands about 5 feet high at the shoulder. It is worth comparing this land animal with the largest *permanent* resident of the Antarctic continent in similar latitudes. As far as the writer is aware this is a tiny spring-tail insect (*Gomphocephalus*), which is about 1 millimetre long. The writer discovered the first live specimens of this important denizen of the Antarctic in November 1911; and this comparison of the two animals drives home the vastly greater possibilities of Polar Canada as contrasted with Polar Antarctica!!

The musk ox has little or no near relationship to either the ox or the sheep, but it has a relative in the *Takin*, which lives on the borders of Assam and Tibet. The horns have very broad bases, curving down and then outward and upward. The animal is covered with long matted hair, and there is a thick woolly under-fur. Stefansson believes that it may be possible to breed these animals in part for this wool, which can be woven into cloth (Fig. 108).

It is one of the hardiest animals known, being able to thrive on the dwarf willows, saxifrages, and grasses, which it can obtain in the winter by pawing away the snow (*vide North-West Territories*, 1930). Unlike the caribou it does not migrate, but moves to other districts only when the pasture is exhausted. Its most southern habitat is in or near the Thelon Sanctuary, which is shown in Fig. 112. For many years no one, white or native, has been allowed to kill these interesting denizens of the farthest northern parts of the Dominion. The largest numbers of the musk ox, said to amount to 8,000, are found equally divided between Melville Island and Ellesmere Island. Bathurst, Prince of Wales, and Axel Heiberg are said to contain over 1,000 in each island. On the mainland, between Thelon Reserve and the coast (Fig. 112), there are said to be 500.

CHAPTER XV

FORESTS, PAPER-PULP, AND WATER-POWER

IN Chapter V some of the main characteristics of the forests of the Dominion are considered, but mainly in relation to their climates and habitats. In the present chapter the economic and industrial aspects of the forests will be discussed. It is convenient to link with the description of the forests those of two very important industries, which are so closely associated with them in nature, i.e. the production of paper-pulp (and of paper), and the exploitation of the water-power in the adjacent forest area. In fact, a waterfall is often the determining factor in deciding the location of a large paper-mill.

The general distribution of useful forests in Canada has been discussed by C. D. Howe much as follows.[1] The land area of the Dominion is about 3,600,000 square miles, but a large proportion of this area consists of barren grounds, prairies, treeless mountain slopes, and land already cleared for agricultural or pastoral purposes. Furthermore, much of the northern portion of the Taiga consists of stunted trees of little value at present for commerce; though it is possible that small timbers with the aid of plastic cements will become of considerable importance in the future. However, ignoring this last possibility, Howe estimates that about 900,000 square miles can carry timber of pulpwood or sawlog size. He next draws attention to the great losses due to fire in this 'satisfactory forest area', and states that during the past seventy-five years at least one-half of the commercial forested area has been burned. Since it takes s many years in the north country to grow a spruce tree of 6 inches diameter, the burned areas as a whole do not contain merchantable trees. Moreover, many areas have been burned over not once, but several times.[1]

General Notes on Distribution

There are something less than a hundred trees of importance in the forests of the Dominion, but of these only some half dozen are almost ubiquitous. We owe to A. T. Drummond a discussion of this feature of the forests given in a book by many authors entitled *Canadian Economics* (Montreal, 1885). The most widespread trees tend to be those with easily transported seeds, such as the paper birch, the two poplars, the black and white spruces, and the balsam fir. They occur in the forests of British Columbia as well as in

[1] *Handbook of Canada*, Toronto, 1924.

the forests of the Taiga right across the continent. Only three of the trees of Canada are to be found in Europe according to this writer, and they are the chestnut (*Castanea vesca*), white birch, and yew (*Taxus baccata*).

In British Columbia there are over thirty common forest trees, and all except seven are confined to this rather small portion of the Dominion (Fig. 113). The Red Cedar extends beyond the province, as do the six ubiquitous species mentioned earlier.[1] In Ontario

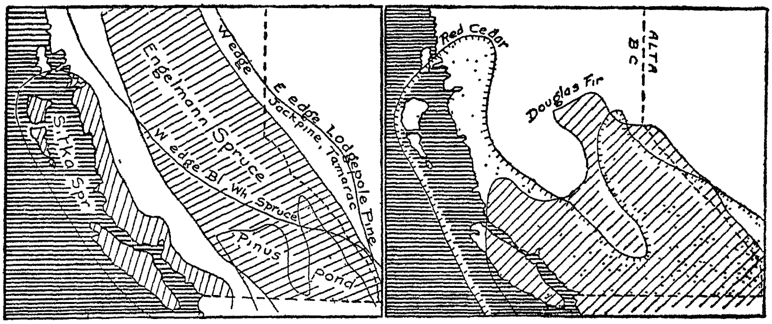


FIG. 113.—The distribution of the chief Timber Trees in British Columbia. Lodgepole Pine covers the whole of the province. The western limits of the widespread trees of the Taiga are indicated also. (Based on R. R. Morton)

there are 65 species, of which 52 are also found in Quebec ; but only 14 seem able to cross the climatic barrier to the west, which exists near the Red River. This is, of course, the line separating the prairie from the forest ; and, as stated earlier, is fundamentally the result of the greater dryness of the air to the west of the Red River. The forests of southern Ontario have now been almost completely removed in clearing the land for farms. Around 1830 it was not uncommon to find trunks of white pine 18 feet in circumference and 160 feet high north of Lake Erie, but they have long vanished. So also in the early days there were many fine specimens of the black walnut (*Juglans nigra*), but today none is to be seen outside such reserves as that at Rondeau Park (south-east of Chatham).

As was to be expected the mountains of the east and west, i.e. the Appalachians and the Rockies, greatly affect the course of the isotherms, as pointed out in the chapter on climate. Thus boreal trees pass southwards along the sides of the mountains from Canada into U.S.A. White and red pine, tamarack, paper birch, and others reach far south almost to Virginia on the sides of the Appalachians. Contrariwise, the narrow valleys of the rivers of British Columbia

[1] The important forests of British Columbia are discussed in Chapter IV (Vegetation).

carry northward many plants and some trees which have their main habitat in the American states to the south.

It was to be expected that most trees of the Taiga would become stunted along their more northern limits, but this rule is not always followed; for the Banksian Pine is found to be big enough to be merchantable near James Bay while in the Ottawa valley it is a shrub (A. T. Drummond). *Arbutus Menziesii* is a tree in British Columbia and a shrub in California (but one would like to be sure that the rainfall is the same in both localities).

The whole question of the growth of trees in former times in the Prairies is a complex one. Some of the open prairie may be due to the greater prevalence of forest fires now than formerly. On the other hand Clements and Chaney, in a recent discussion in *Environment and Life on the Great Plains* (Carnegie Institution, 1937), suggest that the Tundra and the Prairies may have been in contact some 20,000 years ago, when climatic controls were very different from those of today. They think it possible that a very long time must elapse before the forests recover lost ground, even if the environmental factors are fairly suitable in the locality today. Some of the open prairie in their opinion is thus inherited from bygone days with very different physical controls from those obtaining there today.

The following table (from the official report of the Forest Service, Ottawa, 1935) gives the totals of forested lands in the various provinces; as well as the amount of merchantable timber, and the farmlands in the provinces. The latter are arranged in order, which shows that Quebec is the leading forest province.

FOREST AND CROPLANDS IN THE PROVINCES

	Total forest land (sq. miles)	Merchantable timber (sq. miles)	Cleared croplands (sq. miles)	Total potential croplands (sq. miles)
Quebec	373,500	213,500	17,608	68,352
Ontario	240,000	56,100	28,342	102,870
British Columbia	240,000	71,000	3,640	35,317
Alberta	130,635	20,680	54,817	136,641
Manitoba	93,000	4,615	20,489	50,594
Saskatchewan	82,160	7,305	81,508	125,116
New Brunswick	21,962	14,584	2,686	16,747
Nova Scotia	12,000	7,470	2,811	12,644
Prince Edward Is.	725	485	1,331	1,966
Totals	1,194,082	395,739	213,232	550,247
Territories	60,000			14,070

Another interesting table given in the same publication shows the large number of Canadians who are dependent on the forests directly for their livings.

	Capital invested	Number of employees
Woods operations	$112 million	65,000
Lumber industry	80·7 "	18,000
Wood-using industries	99 "	23,000
Pulp and paper industry	559 "	24,000
Paper-using industries	160·5 "	41,000

AVERAGE ANNUAL LUMBER PRODUCTION ACCORDING TO SPECIES (1929 TO 1933)

Conifers		Deciduous	
1. Douglas fir	$17 million	1. Yellow birch	$2·3 million
2. Spruce	17 "	2. Maple	1·2 "
3. White pine	9 "	3. Basswood	0·5 "
4. Hemlock	4 "	4. Poplar	0·2 "
5. Cedar	2·4 "	5. White birch	0·4 "

Character of the Chief Timbers of Canada

The principal forest products of Canada are pulpwood, lumber, and fuel wood. Other important products are shingles, railway ties, poles, laths, cooperage products, plywoods, piles, mine timbers, distillation products, fences, tan-bark, and maple syrup. Of the many trees in the Dominion only 23 species of softwoods and 32 species of hardwoods can be considered as commercially important. The softwoods constitute over 80 per cent of the standing timber, and 95 per cent of the lumber and pulpwood produced.[1]

A. SOFTWOODS (*All conifers*)

Pines, of which five are important sources of timber.

WHITE PINE (*Pinus strobus*) extends from the Maritimes to eastern Manitoba, but is most abundant near the Ottawa valley and the Great Lakes. It is one of the most valuable softwoods in the world. The wood is light in weight, and only fairly strong. It is easily worked, with low shrinkage properties. It is much valued for cabinet work (Fig. 42).

[1] *The Forests of Canada*, Dept. of Interior, Ottawa, 1935, from which the descriptions are taken.

WESTERN WHITE PINE (*P. monticola*) found in humid B.C., but the supply is limited. Properties resemble those of White Pine.

RED PINE (*P. resinosa*).—Much the same habitats as White Pine, but is a hardier tree. Not so tall, usually about 100 feet high. The wood is resinous, and it is used for piles, &c.

PONDEROSA PINE is found in the dry belt of B.C., where it may reach 100 feet in height. It is a hard pine, weighing 32 pounds to the cubic foot. Used in building construction.

JACK PINE (*P. Banksiana*).—Widely distributed (Fig. 87). Rather a slender tree but usually tall and straight. Very hardy, and the cones resist fire. Used for poles, ties, and kraft paper.

LODGEPOLE PINE (*P. contorta*) found in B.C., but in its properties much resembles jack pine.

Spruces.—The principal pulp timbers, and second only to Douglas fir as lumber producers. There are five commercial species (Fig. 42).

WHITE SPRUCE (*Picea glauca*) is widespread, and may reach a diameter of 2 feet. The wood is light in weight and easy to work. It is tough and much used for scaffolds. The long fibres make it specially suitable for paper.

RED SPRUCE (*P. rubra*) is found only in the east. The timber is like that of the white spruce, but is darker and stronger.

BLACK SPRUCE (*P. mariana*) is a smaller species of slow growth. It extends far north and grows in swampy areas. It is favoured for making rayon.

SITKA SPRUCE (*P. sitchensis*) found on the lower slopes near the Pacific coast. It is a very large tree, which may be 6 feet in diameter. The timber is strong, tough, and light, and is much used for aeroplanes.

ENGELMANN SPRUCE is found in the interior of B.C. (Fig. 113), and may grow to 3 feet in diameter and 120 feet high. It supplies good timber, and will be used for pulp as the industry expands.

Hemlock, of which there are two commercial species (Fig. 42).

EASTERN HEMLOCK (*Tsuga canadensis*) found in the south-east of the Dominion (Fig. 42). It grows to 70 feet, with a diameter up to 2 feet. The wood is coarse and apt to warp. It is used for ties and for flooring.

WESTERN HEMLOCK (*T. heterophylla*) occurs only in B.C., and is a tall tree reaching 150 feet. It ranks high for interior finish, for boxes, and for pulp.

Douglas Fir (*Pseudotsuga taxifolia*) found throughout southern B.C. (Fig. 113) furnishes more lumber than any other tree in Canada. It may reach 200 feet in height and 6 feet in diameter. In the dry interior the tree is much smaller. It is characterized by a bark which may be 12 inches thick. The timber is very strong, with a striking ‘ figure . It is available in large planks, and is valued for floors and interior finish.

Cedar or *Arbor Vitae* occurs in two species.

WESTERN RED CEDAR (*Thuja plicata*) found in B.C. where it may grow to 100 feet with a diameter of 10 feet. The wood is light and soft, and is used everywhere for shingles; as well as for telegraph poles, and for boat-building.

EASTERN WHITE CEDAR (*T. occidentalis*) is a much smaller tree found in the eastern half of the Dominion. It is much used for shingles and boat-building, but a large tree is now rare.

Yellow Cedar (*Chamaecyparis*) is found in B.C., and produces a timber which is strong, hard and durable. It is used as a cabinet-wood.

Firs occur in four species of commercial importance.

BALSAM FIR (*Abies balsamea*) occurs in the prairies, and east of the Dominion. The wood is like the spruce, and is used for pulp. Canada balsam is produced from this tree.

GRAND FIR, Amabilis fir, and Alpine fir are all found in British Columbia, and are not of much commercial importance to date.

Larch occurs as two species of some commercial importance (Fig. 42).

WESTERN LARCH (*Larix occidentalis*) is found in the drier parts of southern B.C. The wood is heavy (38 lb. per cu. ft.) and very strong. It is used for ties and construction, but is not common.

TAMARACK (*L. laricina*) found from the Rockies to the Atlantic, usually in swampy areas. It is strong and used for ties, &c. Much has been killed by the saw-fly invasion.

B. HARDWOODS (*All deciduous*)

Poplar comprises three species which are of commercial importance.

ASPEN (*Populus tremuloides*) is a hardy, quick-growing but short-lived tree, and is seldom sound after it reaches 10 inches in diameter. The wood is soft, light, and perishable; but is used for excelsior and for floors. In the east it produces soda-pulp.

BALSAM POPLAR (*P. balsamifera*) has as wide a range as the preceding, and is used for the same purposes. It usually grows on wetter ground.

BLACK COTTONWOOD (*P. trichocarpa*) is confined to the Pacific coast.

Birch has a number of species, but only three are important.

YELLOW BIRCH (*Betula lutea*) is the most important hardwood in Canada, and spreads from Lake of the Woods to the Atlantic. It may grow to 100 feet; and produces a strong heavy wood, weighing 44 lb. per cu. ft. It is used for furniture, and is a good fuel.

WHITE BIRCH (*B. papyrifera*) grows to 50 feet, especially after fires. It is used for turnery, fuel, and soda-pulp. A closely allied species grows in British Columbia.

Maple; of which four or five are of commercial importance.

SUGAR MAPLE (*Acer saccharum*) is second only to Yellow Birch in importance, and it grows in the same region, up to a height of 80 feet. It has much the same uses as yellow birch.

RED MAPLE (*A. rubrum*) is softer than the former, but is used in the same way.

SILVER MAPLE (*A. saccharinum*) is found near the lower Great Lakes.

BROAD-LEAVED MAPLE (*A. macrophyllum*) is an ornamental tree found only in British Columbia.

MANITOBA MAPLE (*A. negundo*) is planted as a wind-break on the prairies.

Basswood (*Tilia glabra*) is used for delicate cabinet-work in the south-east.

Elm occurs chiefly in two species.

WHITE ELM (*Ulmus americana*) extends from Saskatchewan to the Atlantic, and may grow to a height of 125 feet. It furnishes a heavy tough wood, used for barrels, pews, &c.

ROCK ELM (*U. racemosa*) found in Southern Ontario, weighs 49 lb. per cu. ft. and is used where tough, hard wood is desirable.

White Ash (*Fraxinus americana*) grows east of Lake Huron, and is tough and elastic.

Beech (*Fagus grandifolia*) gives a heavy but brittle wood, used for floors.

Oak, whether White or Red, is a valuable wood, but too rare to be of much commercial importance. Both are found along the south-east border of the Dominion. White oak makes excellent barrels.

The Forest Situation in Manitoba

As an introduction to the study of Canadian forests those of the province of Manitoba may serve as fairly typical, since this is a central area which contains samples of all the main forests. Moreover a valuable study has appeared recently by J. D. B. Harrison, which is the first of a series of similar studies which will ultimately cover the whole Dominion.[1]

In the early days there seemed no likelihood that there would be any scarcity of timber for centuries, but with the advent of the paper-pulp industry it soon became clear that supplies were quite limited, in view of the extensive areas depleted each year. The first surveys in Manitoba were commenced in 1905, after certain areas had already been set aside as reserves, chiefly along the Manitoba escarpment. The use of aircraft to prevent fires began in 1921, and in about ten years there were six stations employed in this valuable service. In

[1] *The Forests of Manitoba*, Bulletin 85, Dept. of Interior, Ottawa, 1934.

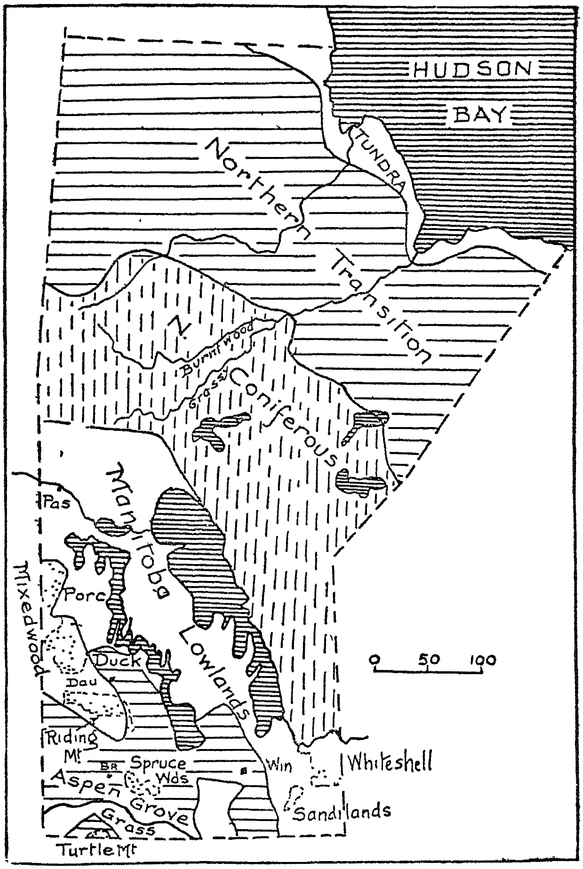


FIG. 114.—The distribution of the Forest Zones in Manitoba. (Based on J. D. Harrison)

1929 the natural resources were transferred from Dominion to provincial control, including the reserves mentioned above. These are given in the following table, with their areas in square miles (Fig. 114).

FOREST RESERVES IN MANITOBA

Porcupine	775 sq. miles	On the scarp north of Brandon
Duck Mountain	1,426 ,, ,,	*do.*
Riding Mountain	(Now a Park)	*do.*
Spruce Woods	224 sq. miles	On the scarp south of Brandon
Turtle Mountain	109 ,, ,,	*do.*
Sandilands	189 ,, ,,	South-east of Winnipeg
Whiteshell	1,078 ,, ,,	East of Winnipeg

In a number of interesting pages Harrison describes the indirect value of the forests to the community. Among these are the timber supplies necessary for buildings and fuel for the settler, and as shelter belts for gardens and stock. Forests are of great importance in regulating the supply of water to streams, and thus preventing floods. After a forest is removed the pleasant streams become open gullies, either flooded or empty of water. Soil erosion is rapidly increased if the vegetation cover is ruthlessly destroyed by man or animals. Forests are vital for fur-bearing animals, and as refuge for insect-eating birds, &c., while parks for recreation are a necessary feature of modern city life. As a complementary occupation to the heavy demands of the grain crop on the farmer in the warmer months, the forests offer lumbering as a source of cash-money during the months too cold for agriculture.

The general environment of the province of Manitoba has been discussed in earlier chapters. Approximately half the province exhibits the rather sterile soils characteristic of the Canadian Shield. It may be noted that an extensive 'clay belt' embraces the valleys of the Burntwood and Grassy Rivers, which unite to form the Nelson River (Fig. 114). An important asset on many of the rivers is the large amount of water-power which is available for use in pulp-mills, &c. The Winnipeg River is already highly developed for this purpose.

In most of the forest reserves the soil is due to the deposition by the ice of vast terminal moraines. But the small 'Sprucewoods Reserve' is composed of windblown sands, derived from delta deposits laid down in the large glacial lakes of bygone times. The Whiteshell Reserve is sparsely covered with the rather poor soils characteristic of the Canadian Shield. Too often such shallow soils are almost as completely destroyed by forest fires as are the trees themselves.

There are five forest belts in Manitoba, which cover the province between the Tundra belt on the coast of Hudson Bay and the small region of grasslands in the extreme south-west corner (Fig. 114). The *Aspen Grove* belt is now rather fully taken over by the farmer, but it still contains many groves (or 'bluffs' as the farmer terms them) of the aspen (*Populus tremuloides*). Some bur oaks and Manitoba maples are also found in this belt. The *Mixedwood* belt is rather small in area, but contains the chief elevations of the province. These are now reserves, and are shown by the dotted regions in Fig. 114. The soil in this section is well suited for the growth of forests, and there are many stands of aspen and of white spruce. The *Manitoba Lowlands* contain many muskegs and swamps, and some of the drier sites support a forest like that of the mixedwoods. The *Northern Coniferous* belt grows on the poor soils of the Canadian

Shield. The forest consists mainly of a mixture of black spruce and jack pine, and much of this belt will be utilized in the near future. The *Transition* belt, still farther to the north, contains trees which are stunted by the cold climate, and which are only useful as local fuel. Harrison says that this region is not likely to be of any substantial value for forestry.

To the newcomer the terms 'hardwood' and 'softwood' need some explanation. The terms are really synonymous with 'Deciduous' and 'Coniferous' respectively; and are a little confusing, since the wood of jackpine is *harder* than that of the aspen, though the former is classed among the 'softwoods'.

The timber values of these trees vary considerably, and the following table will make their economic properties clearer.

MANITOBA TIMBERS

Tree	Genus	Height	Uses
	SOFTWOODS		
White spruce	*Picea glauca*	100 ft.	Light colour, straight grain, durable, used for sawn lumber.
Black spruce	*P. mariana*	80 ,,	Long fibres, dense wood, forms most of pulpwood in Manitoba.
Balsam fir	*Abies balsamea*	70 ,,	Poor wood, much fungus, rarely used.
Jack pine	*Pinus banksiana*	70 ,,	Resists rot, fair lumber, fuel.
Tamarack	*Larix laricina*	65 ,,	Heavy, strong, durable; but spoilt by insects in much of province.
White cedar	*Thuja occidentalis*	50 ,,	Weak timber, but durable in soil.
	HARDWOODS		
Aspen	*Populus tremuloides*	70 ft.	Weak and soft; much fungus if old.
Black poplar	*P. balsamifera*	55 ,,	Stronger than aspen, used for floors.
White birch	*Betula papyrifera*	60 ,,	Scattered, used for fuel.

The estimate of the total supply of mature standing timber in the province is given by Harrison as 3,533 million cubic feet, of which 1,357 million are conifers, and 2,170 million are hardwoods. The distribution is given in the map Fig. 115, where the chief timber supplies in each region are charted. Thus in the rich soils of the south-west corner, aspen is much the most abundant with black spruce far behind. In the poor soils of the south-east, aspen again leads, but Jack pine and black spruce tie for second place. On both sides of Lake Winnipeg aspen and black spruce come first; while farther to the west the two poplars are the chief timbers. In the 'Mountain' region (middle-west) there is the largest supply of white and black spruce *saw-woods* of any district, but their amounts are far behind those of the trees charted on the map. In the far

north is the sole region where black spruce replaces aspen as the leading timber (Fig. 115).

The normal area annually cut in Manitoba comprises approximately 63 square miles of conifers, and 43 square miles of hardwoods. From a study of the fire scars in the timber it is possible to learn something of the prevalence of disastrous fires in the past. Thus fires were very prevalent about 1830 to 1840. Again in 1885 a series of fires commenced which seemed to sweep clean the forest areas of the province; at any rate, 71 per cent was ruined. Again in 1919 fires destroyed nearly all the timber in one of the best districts, the eastern face of Porcupine Mountain. 1928 and 1929 were also bad fire years. After a fire quite a different forest, often composed of jack pine and aspen, may replace the former types. Sometimes grass or brush grows up, which delay the growth of a true forest for many years. The normal loss per annum from fire is about 20 million cubic feet, and more than half of these fires are caused by human carelessness.

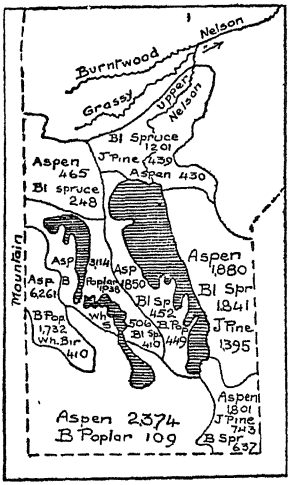


FIG. 115.—Estimates of merchantable timber in Manitoba in thousands of cords. (Based on J. D. Harrison.) Some spruce is omitted in the 'Mountain' district

The Forests of Quebec

A glance at the map given in Fig. 116 will show that the sawmills of Quebec are the most numerous of those of any province. They are especially dense along the Ottawa River and its northern tributaries, and again on the southern shore of the St. Lawrence near Cabano and Matane. In recent years the forests in the far west (Abitibi) are being extensively cut. Thus a description of these forests and their products can be taken as fairly typical of the eastern portions of the Dominion.

Annual production of the forests of Quebec amounts to 750 million cubic feet of timber, which provides work for some 50,000 men.[1] In recent years the gross value of production of the Quebec pulp- and paper-mills averaged \$60 million; that of the sawmills was worth \$20 million; while other wood-using industries amounted to some \$14 million. Forest production ranked next to

[1] 'Forestry in Quebec', by Avila Bedard, *Canad. Geog. Jnl.*, June 1944.

agriculture; the annual values being $208 million and $177 million respectively.

In 1940 there were 10 pulp-mills, 10 paper-mills, and 26 pulp- and paper-mills in the province (Fig. 117). The number of saw-

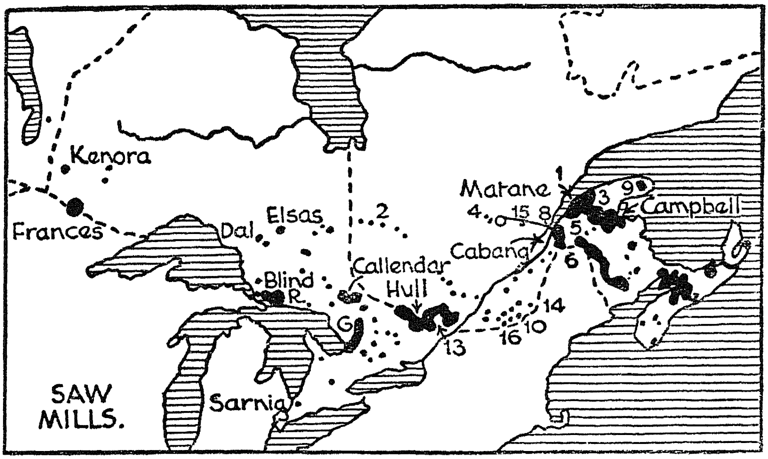


FIG. 116.—Distribution of sawmills in eastern Canada The numbers in Quebec refer to the table in the text

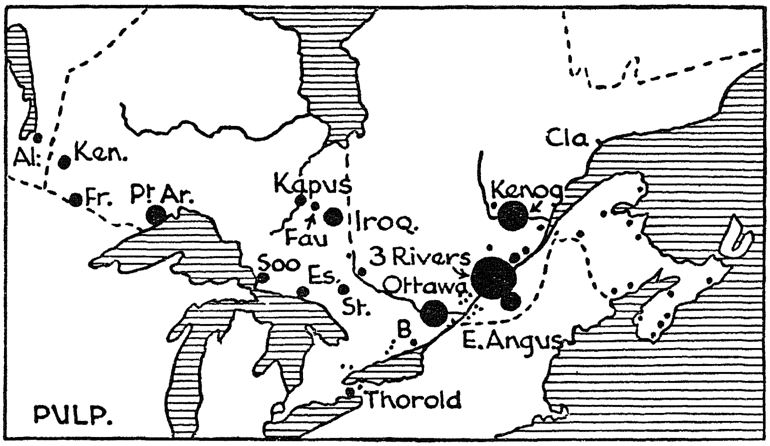


FIG. 117.—The distribution of the chief pulp- and paper-mills in Canada

mills is given in the following table, where the counties are arranged somewhat in the order of their importance in the lumber industry. These numbers appear on Fig. 116.

SAWMILLS IN QUEBEC, 1940

County	Site	Large sawmills	Small sawmills
1. Temiscouata	E.	13	84
2. Abitibi	NW.	22	88
3. Bonaventure	E.	8	40
4. Lac St. Jean	NE.	4	95
5. Matapedia	E.	10	25
6. Kamouraska	Centre	9	24
7. Pontiac	SW.	5	17
8. Rimouski	E.	4	46
9. Gaspé	E.	3	80
10. Beauce	S.	5	58
11. Champlain	Centre	4	43
12. Portneuf	Centre	4	66
13. Labelle	SW.	6	44
14. Dorchester	S.	2	52
15. Chicoutimi	N.	1	83
16. Frontenac	S.	6	34

Bedard classifies the forest zones of the province in three belts. The first is the *Valley Plain* of the St. Lawrence, which extends from the Ontario border to Quebec, and is then continued along the south shore as far as Matane. This is the land which was first divided into seigneuries. Yellow birch, maple, basswood are the chief timbers, with much spruce and balsam fir and hemlock. The timber is used for many small industries, while the lumber and pulp supplies come from the higher hinterlands outside this belt.

The second belt comprises the Appalachian mountains with their smaller subdivisions, the *Notre Dame* and *Shickshock* Mountains. From the Chaudière valley east to Gaspé the softwoods are dominant, especially spruce and balsam fir. The rivers are rather small, so that the water-power is not so abundant here as in the last belt. The *Laurentian* area includes all the northern forests of the province as far as the parallel of 52° N.; i.e. about level with the south end of James Bay. Originally this was a grand area for white pine, but much of it has now been cut. The spruce and balsam fir are in great demand for pulp-mills, especially on the Gatineau, Lievre, and Rouge Rivers, which enter the Ottawa River from the north.

The sociology of the forest industry is discussed at length by A. R. M. Lower in *Settlement and the Forest Frontier*, Toronto, 1936. He there describes the conditions obtaining around a paper-mill employing about 100 employees, which would produce 100 tons of pulp per day. In the year (310 working days) this mill would consume about 39,000 cords of wood. This would need 500 men for the cutting in three months, 250 men for two months for the hauling,

and 125 men for the driving. Annually the mill would employ about 300 men in all and about 65 horses for the winter.

The Pulp and Paper Industry

We are told that paper was invented by T'sai Lun about 105 B.C. He discovered that if macerated vegetable fibres are suspended in water, which is later drained through a perforated tray, then the fibres interweave and form a mat. This mat can be pressed and dried, and thus paper is formed. From China the art spread to India and Europe, where a Dutchman invented the beater, and a Frenchman the fourdrinier machine. Later, in Canada, a German and a Canadian showed how to grind the wood to a pulp, and other nations invented the chemical processes producing sulphate and sulphite pulps.[1]

In the year 1805, when Ware started the first paper-mill at St. Andrews to make paper for the *Montreal Gazette*, Fourdrinier was still working at the machine for making paper in a continuous sheet. About 1826 a mill was erected in the Don valley, Toronto; and like all the early mills, it used rags for the basis of the paper. About 1832 the new cylinder machines were in operation at Toronto. The introduction of pulp from wood has led to Canada becoming the world's second largest producer of paper; and it ranks first among the manufacturing operations in the Dominion. Alexander Buntin about 1866 is credited with making the first commercial ground-wood paper in Canada. In 1864 the first chemical pulp-mill was in operation, but all these early mills only produced cheap and poor papers, the better varieties still coming from Europe.

In 1882 the first mill to produce good paper was started at St. Jerome, Quebec; and about 1887 sulphite paper was produced at Cornwall. This was followed in 1908 by the first sulphate (kraft) pulp-mill in America at East Angus (Q.). In 1900 there were 28 paper-mills which employed 2,730 people and turned out paper worth over $4 million. There were also 25 pulp-mills, whose product was worth about the same amount. The great increase since that date is apparent in the table on p. 372.

Practically all the pulpwood timber is on land owned by the people; so that a firm seeking the right to cut wood asks for a certain area to be opened for tender, and such firm is charged a ground rent. The sale of this wood has been for many years the chief source of provincial revenue. About 1900, embargoes were placed on the export of *unmanufactured* pulp-wood; and, as a result, there has been a great flow of American capital into Canada to develop the processing of pulp and paper within the Dominion.

[1] 'Canada's Paper Industry', J. N. Stephenson, *Canad. Geog. Jnl.*, November 1939.

PAPER PRODUCTION BY PROVINCES, 1952

	Quantity in tons	Value in dollars
Quebec	3,515,193	$339,554,493
Ontario	1,963,463	246,215,714
British Columbia	540,140	62,261,263
Remainder	1,183,064	128,964,752
Total	7,201,860	$776,996,222

There are two major methods of obtaining the fibrous material from which paper is made in Canada. The earlier method is purely *mechanical*, in which the logs of wood are forcibly pressed against a rapidly rotating grindstone, thus converting the wood into fibrous shreds. In the *chemical* methods the chips of wood (produced from logs by a revolving cutter) are digested with various chemicals. These destroy the non-fibrous portions of the wood, and leave the fibres in a purer form than does the mechanical method. There are three chemicals mostly in use, sodium sulphate, sodium sulphite, and sodium hydroxide; and these produce the pulps known as 'sulphate', 'sulphite', and 'soda' respectively.

The fibres are now washed and bleached, and then the pulp is fed on to a fine wire screen, which moves forward all the time, and drains off the water. Thus a film of uniform fibres is formed, and this is led through rollers, which compress it into a soft sheet of wet paper. Later treatment with heat and pressure transforms it into a tough absorbent paper. The first 'paper machines' were erected at Frogmore (Herts.) in England in 1803 by Fourdrinier, a Frenchman.

Canada's rivals in the wood-pulp market are U.S.A., England, Germany, Japan, and the Scandinavian countries. In the export of pulp Sweden is in the lead, with Canada, Norway, and Finland each running a fairly close second. Canada is, however, the world's greatest exporter of 'newsprint', i.e. rolls of paper in a stage ready for printing in the presses. Most of this (99 per cent) goes to the United States, and in 1942 newsprint used 77 per cent of the total production of Canadian pulp.

In 1935 Canada produced 3,868,341 tons of pulp, and about 79 per cent was used to make paper in Canadian mills. Of the total pulp production 64 per cent was ground-wood, 17 per cent was unbleached sulphite, 10 per cent bleached sulphite, and 6 per cent sulphate.

Geographical location is an important factor in deciding the site of a large pulp- or paper-mill. In addition to a plentiful supply

CHIEF PRODUCERS OF NEWSPRINT (AVERAGE FOR 1928–39)

	Short tons		Short tons
1. Canada	2,620,000	7. Newfoundland	293,000
2. United States	1,058,000	8. Sweden	272,000
3. United Kingdom	831,000	9. France	294,000
4. Finland	326,000	10. Norway	185,000
5. Japan	337,000	11. Russia	144,000
6. Germany	504,000	12. Netherlands	91,000

of the spruce and fir trees, power and transport facilities are vital. There is a considerable advantage in placing the mill where a main railway cuts across a large river. In this case it is easy to float the logs downstream to the mill, and then transport the pulp by rail. Two examples are the well-known mills at Kàpuskàsing and Fauquier (Plate II), which are sited on long rivers flowing northwards to the Canadian National Railway (Fig. 117). Sites such as those on the Great Lakes at Port Arthur and ‘ Soo ’, can collect logs floated down all the rivers entering the lake.

Hydro-Electric Power

The development of hydro-electric power is closely linked with the forests and the pulp industry. In recent years power to the amount of 600,000 horse-power has been developed by the paper companies themselves, while no less than 55 per cent of all power sold by central stations for industrial purposes is used in the pulp-mills. The distribution of these hydro-electric plants across the Dominion is indicated in the following table, which is taken from the very useful account given by J. T. Johnston in the *Engineering Journal* (Montreal) in June 1937. The data for 1943 are added, as well as an estimate of the total power which will be available in the future.

CANADIAN WATER-POWER DEVELOPMENTS

Province	1920	1943	1955	Available
Quebec	955,090 h.p.	5,847,322 h.p.	7,773,000 h.p.	13,064,000 h.p.
Ontario	1,057,422 „	2,673,443 „	4,845,000 „	6,940,000 „
Br. Columbia	309,534 „	796,024 „	2,246,000 „	10,998,000 „
Manitoba	85,325 „	422,825 „	756,000 „	5,344,000 „
N. Brunswick	21,976 „	133,347 „	164,000 „	169,000 „
Nova Scotia	37,623 „	133,384 „	171,000 „	128,000 „
Alberta	33,122 „	94,997 „	258,000 „	1,049,500 „
Saskatchewan	—	90,835 „	109,000 „	1,082,000 „
Total	2,515,559 „	10,214,513 „	16,684,000 „	39,511,700 „

The necessary geographical conditions for extensive water-power development are large supplies of river water combined with fairly

considerable drop in the level of the rivers. Thus a good rainfall and a fairly elevated region are the best environments. In Canada these are, on the whole, found in Quebec to a greater extent than in any of the other provinces. It is true that the mountains are much higher in British Columbia, but the catchments are not so satisfactory, and in general the interior of British Columbia is distinctly dry. However, the *available* supply in this province comes second. The prairie provinces do not offer much elevated land; but of the three, Manitoba has the largest extent of Shield with a fair rainfall, and so it is in the best position to supply hydro-electric power.

The commercial development of 'hydro' leads back to 1831, when Faraday made the experiments which led to the development of electricity from rotating coils, and so paved the way for the creation of the modern dynamo. Early uses of the new power were usually made in connexion with lighting; but turbines actuated by water were first used in Canada in 1882, when Young's sawmill at Ottawa was lighted with the aid of such machinery. In 1891 alternating current at 16,000 volts was transmitted for 112 miles in Germany, and similar installations soon spread through Europe and North America.

Ontario was the first province to develop and distribute power; and this was largely due to the presence of Niagara Falls, coupled with the fact that there are no important coal supplies in the province. In 1906 a commission was formed to act as trustee for the municipalities in distributing energy through the province. In Quebec public ownership has not made much headway, perhaps because here the power is so largely linked with private enterprise in the paper industry. In British Columbia, since the population is so largely concentrated near Vancouver, power is chiefly distributed by private companies. In the other provinces power, as in Ontario, is mainly distributed by public utility companies (Fig. 118).

Some further details of the growth of the power service will be of interest. By 1887 Ottawa, Cornwall, Peterborough, Soo, Pembroke (all in Ontario), and Quebec and Hull (in Quebec) had electric services. In 1893 two 1,000 h.p. units were installed at Niagara to operate an electric tramway, and to furnish light. In 1894 three units of the same type were installed at Montmorency Falls (near Quebec City). In 1897 power from Batiscan River was transferred 18 miles to Three Rivers; and this is perhaps the first example in the Empire of such long-distance transmission. By the end of 1900 water-power installation had reached a total of 173,000 horse-power.

Power was first transferred from Niagara Falls to Toronto in 1906. At the important Shawinigan Falls on the St. Maurice River —about 20 miles north-west of Three Rivers—power units were installed in 1901, and by 1903 electricity was supplied to Montreal.

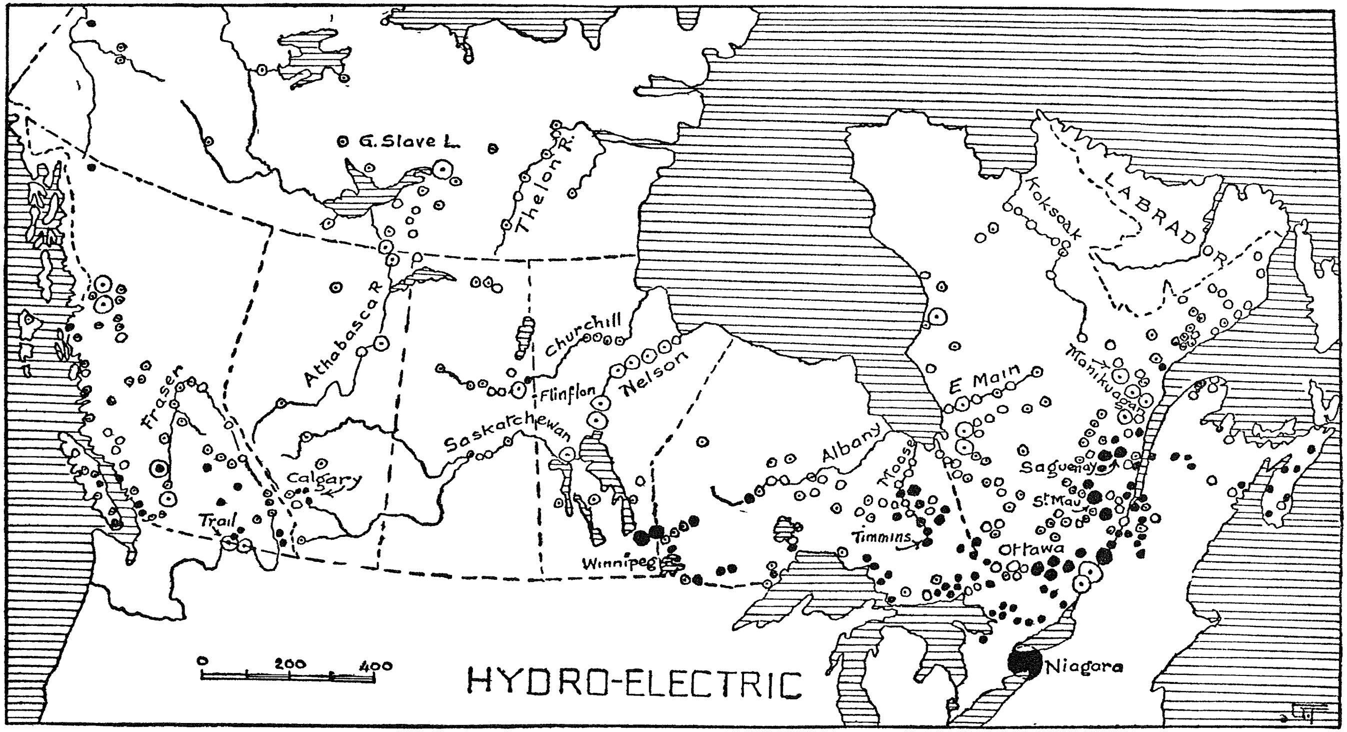


FIG. 118.—Map showing the chief hydro-electric sites in the Dominion. Note the abundance of power in the empty lands of Canada. Black dots show utilized power, open circles not yet utilized. (*Canadian Year Book*)

Vancouver was supplied from Coquitlam in 1904; while Rossland-Trail was served from the Kootenay River by 1906.

The Hydro-electric Power Commission of Ontario delivered power from Niagara to Kitchener in 1910; but in 1917 the Commission began the immense Chippewa-Queenston project, from which power was delivered in 1922. Today the Commission operates 46 power plants, though the Queenston plant at Niagara of 500,000 h.p. is much the largest. In the decade 1920–30 huge plants were erected on the Saguenay River, on the St. Maurice River, at Great Falls in Manitoba, on the Stave River (B.C.), and on the Churchill River at Island Falls. Since then very large plants are now utilizing more of the power on the Saguenay, St. Lawrence, Lievre, and St. Maurice Rivers, as well as further afield in the centre and west of the Dominion.

The map which appears in Fig. 118 shows the chief localities (where hydro-electric power is *used*) as black circles; the sites where valuable power resources occur, but which are *not yet utilized*, are shown by the open circles. The concentration of water-power north of the St. Lawrence and in British Columbia is clear from this map. Naturally it is in the vicinity of the main industrial districts that the water-power has been utilized first. Hence the black circles are apparent near Vancouver and Trail in the west; near Winnipeg in the centre; and along the southern margins of the Shield in southern Ontario and Quebec. However, the cluster of power plants near the metal mines of Timmins (where also there are good pine forests for pulp) is worth noting, since these are rather distant from present centres of population.

Special attention should be given to the fact that much of the water-power of the future will be obtained in northern regions where today there is no settlement. Thus the north centre of British Columbia is one such area; the southern shores of Great Slave Lake are plentifully endowed with power, as also is the Thelon River. The Churchill and the Nelson Rivers are peculiarly rich in power resources, which can easily be tapped now that the railway to Churchill runs alongside parts of both rivers. So also the basin of the Albany contains only a few trappers and Indians today, but may easily come to resemble the upper waters of the Moose River. In this last case the claybelt, the pulp-mills, and the metal mines have led to large developments of water-power—all of which are probabilities in other parts of the great Canadian Shield. Even the interior of Quebec province is well endowed in this respect, and the same is true of Labrador, though the sites are not shown on the present map.

The writer of this volume has spent twenty years investigating the possibilities of 'Empty Australia', where no water-supply of any kind occurs, for the most part. Here in 'Empty Canada' conditions

of settlement are not easy, but they are much more promising than in 'Empty Australia', where there is no water, no power, no crops, no timber, and no fuel—all of which are relatively abundant, or possible in the future, in much of the empty Canadian area.

Some Large Hydro-Electric Plants in Canada [1]

British Columbia.—In this province Vancouver is served by five stations with a combined installation of 219,000 h.p. The first power was obtained from Coquitlam on Burrard Inlet, but then other stations at Alouette and on the Stave River to the north were linked to supply the big city. Victoria is served by two stations on the Jordan River, and by another at Goldstream. The Bonnington Falls on the Kootenay River near Nelson have been used for power for the adjacent towns, mines, and smelting-plants. Farther to the east the Bull and Elk Rivers give about 22,000 h.p. for the mines near Fernie. Along the coast are mills at Powell River and Ocean Falls. For the Nechako-Kitimat plant, see p. 203.

Alberta.—The chief plants are on the Bow River near Calgary, and give a total of 70,000 h.p. They are linked with many towns between Edmonton and the southern border, which they supply with light and power.

Saskatchewan.—The only important plant is one on the Churchill River at Island Falls. This generates 42,000 h.p. and is used at the large mine of Flinflon on the borders of Manitoba, and 60 miles from the hydro plant (Fig. 118).

Manitoba.—In 1906 a large hydro plant was erected at Pinawa on the Winnipeg River, giving 38,000 h.p. These supplies have been greatly increased by tapping the power of Great Falls, Seven Sister Falls, and Slave Falls; so that about 450,000 h.p. will ultimately be available for the factories of the city of Winnipeg and adjacent towns.

Ontario.—At first the power generated at the great falls of Niagara was used in U.S.A.; but a Canadian plant was built in 1904, and many companies followed suit, the largest being the Hydro-electric Power Commission of Ontario, whose plants have been mentioned earlier. A new plant at Niagara will produce 1½ million h.p.

Many important plants are in operation in northern Ontario, such as those utilizing the power of the Cameron Falls and the Alexander Falls on the Nipigon River. This power is taken to Fort William and to neighbouring mines. Near the large Sudbury nickel mines several of the rivers have been harnessed, such as the Wapapitei and Abitibi. Kenora has an installation on the Lake of the Woods which supplies about 30,000 h.p. On Rainy River in the same

[1] Based on the illustrated article by J. T. Johnston, cited earlier.

region is a plant supplying 36,000 h.p. to paper-mills in the vicinity. The Kaministiquia River gives electricity to Fort William, and the low falls of Sault St. Marie produce about 30,000 h.p. for the factories at that town. Other falls on neighbouring rivers are also utilized at the 'Soo'. Over 100,000 h.p. is supplied to the huge goldmines at Porcupine, Kirkland Lake, &c., from such rivers as the Metabetchuan and Mattagami. The Abitibi Company, in this north-east corner of the province, has supplies amounting to 176,000 h.p. based on the Abitibi, Sturgeon, and other rivers. The paper-mills in the Kapuskasing district have a large plant at Smoky Falls on the Mattagami River (Fig. 118).

Quebec.—As mentioned earlier this province contains the largest resources of water-power, but it is only in the present century that they have begun to be used on a large scale. The plants in operation are naturally found chiefly in the south of the province in the basin of the St. Lawrence; i.e. on the main river and on its tributaries the Ottawa, St. Maurice, Saguenay, Richelieu, and St. Francis. Montreal was early supplied with power from the Lachine Rapids, then the Chambly and Cedars plants were erected. The Shawinigan Power Company has many important plants to the east of Montreal, so that it rivals the Ontario Hydro-electric Commission. At the Shawinigan Falls themselves it obtains 278,000 h.p.; and there are other plants at Grand Mère, La Gabelle, Batiscan, Montmorency, Chaudière, &c. At Bersimis (NE. of Saguenay) 1½ million h.p. is in use.

To the south of the St. Lawrence there are several large power stations on the St. Francis River near Drummondville and at Hemming Falls. In the Saguenay basin the first station was sited at Jonquière in 1906, but these early stations have been quite overshadowed by the plants at Isle Maligne (495,000 h.p.), and at Chute à Caron (260,000 h.p.). During the war the immense plant at Shipshaw has been put into operation. The water of the Saguenay River is led along the north bank and then given a fall of 208 feet into the turbines. There are a dozen of these, each of which produces 95,000 h.p. Much of this power is consumed in the large electric aluminium-smelting furnaces at the neighbouring town of Arvida (Fig. 50).

There is another large group of hydro-electric plants on the Gatineau and Lievre Rivers, which enter the Ottawa River below Ottawa. These produce about 500,000 and 250,000 h.p. respectively. Other turbines driven by the waters of Chat Falls give 112,000 h.p. Many storage reservoirs have been built on these rivers, especially on the Gatineau, which are said to have trebled the minimum flow.

New Brunswick.—The power of the Grand Falls on the St. John River was developed mainly between 1928 and 1931. The Musquash,

Nipisguit, and St. Croix are among the smaller rivers which are also harnessed.

Nova Scotia.—The plants are small compared with those of the other provinces. Those at St. Margaret Bay, East River, and Mersey River are perhaps the most important. They supply power and light to paper-mills and to the towns in the vicinity.

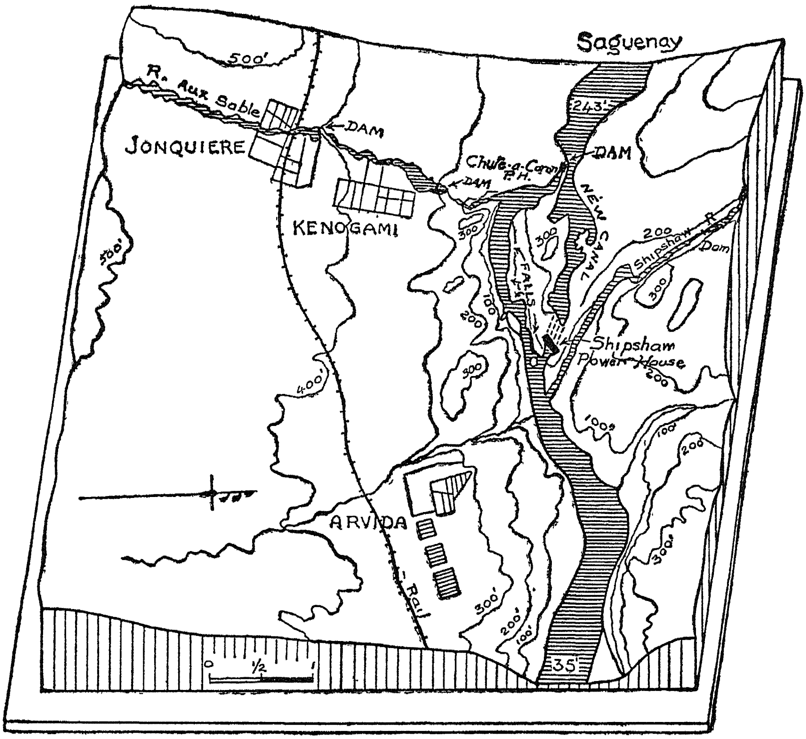


FIG. 118A.—A block diagram showing the hydro-electric power stations on the Saguenay at Shipshaw and Chute-a-Caron. The three industrial towns of Arvida, Jonquiere and Kenogami are also charted

CHAPTER XVI

AGRICULTURE, LIVESTOCK, AND IRRIGATION

Introduction

CLOSE settlement in a young country depends chiefly on the amount of farmland which is available. In later stages, which Canada is now approaching, the industrial factor alters the distribution of population greatly; but even so, the distribution of the farmlands is an excellent indication of the areas where the most people are likely to live, since it is a peculiar fact that the great coalfields are almost wholly found in regions of fair agricultural value.

In another volume dealing with Australia (in this series of Advanced Geographies) I have discussed the position of Australia among the world's farming lands. The following table is borrowed from that study, but the data are obviously only approximate in some continents. (See also the previous table on p. 360.)

CROPLANDS IN THE CONTINENTS

Continent	Population	Estimate of croplands
Asia	1,190 millions	800 million acres
Europe	500 "	570 " "
North America	144 "	360 " "
Africa	124 "	113 ? " "
South America	65 "	68 ? " "
Australia	7 "	23 " "
For comparison :		
Canada	11 "	61 " "
U.S.S.R.	166 "	343 " "
France	42 "	56 " "
Germany	70 "	51 " "
United Kingdom	40 "	30 " "

From this table we learn that Canada is much more important in the agricultural field than the whole continent of Australia, and grows about as much in the way of crops as does South America. It is far behind U.S.S.R. in this respect, but considering its relatively small population, is much ahead of France, Germany, and the United Kingdom. The production of both wheat and oats has been declining in Canada since 1927 as Fig. 119 shows.

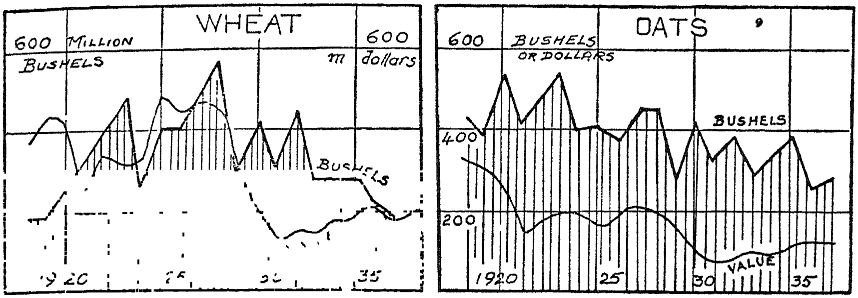


FIG. 119.—Variations in the total crop, and in the values of Wheat and Oats, during the period 1918 to 1937. (*Canadian Year Book*)

An interesting table in the *Canada Year Book* for 1943–44 shows how the croplands of the Dominion have expanded since 1871.

CROPLANDS, IN THOUSANDS OF ACRES

	1871	1881	1891	1901	1911	1921	1931	1941	50 years
Wheat	1,646	2,366	2,701	4,224	8,864	17,835	26,355	21,587	8 times
Oats	—	—	3,961	5,367	8,656	13,879	12,837	12,266	3 ,,
Barley	—	—	868	871	1,283	2,043	3,791	5,304	6 ,,
Corn (Maize)	—	—	195	360	293	205	131	300	1·5 ,,
Potatoes	403	464	450	448	464	534	591	507	0·2 ,,
Hay	3,650	4,458	5,931	6,543	8,289	8,678	9,114	9,559	2 ,,

In this discussion of agriculture, and its distribution in the Dominion, the logical procedure seems to be to consider the character and amounts of the various crops, and their distribution among the various provinces. The crops naturally vary a good deal, since there are four different environments in *southern* Canada—where alone the important crops are grown. The cool wet lands of the Maritimes and of eastern Quebec differ from those of the old settled parts of Ontario and western Quebec, which have a more continental climate. These in turn differ greatly in regard to soil and climate from the lands of the prairies. Our fourth major division is found in British Columbia, where the mountain topography and the arid character of much of the interior, separate this region from the three just mentioned (Fig. 120).

In the continent of Australia two of the subjects mentioned in the title of this chapter are of much greater significance than they are in Canada. These are livestock and irrigation. Owing to the warm arid character of most of Australia, pastoral interests are paramount over all the interior, while irrigation is very significant on the borders of the south-eastern croplands. In Canada, with its cooler, wetter climate, field-crops are relatively much more important

than in the southern continent, and irrigation plays only a small part even in the far west. It therefore seems unnecessary to give separate chapters to these two subjects, as was done for Australia.

It would seem to be convenient to study the distribution of the crops across the continent first of all, pointing out how the major crops change as we traverse from east to west.

1953: ACREAGE OF PRINCIPAL FIELD-CROPS BY PROVINCES
(*thousand acres*)

Crop	Sask.	Alta.	Ont.	Manit.	Que.	N.Br	Nov. S	B.C.	P.E.I.	Total
Wheat	16,100	6,340	766	2,208	11	3	1	81	3	25,513
Oats	2,721	2,357	1,548	1,412	1,380	152	56	98	100	9,830
Barley	2,745	3,489	171	2,365	56	9	3	68	5	8,911
Flax seed	342	164	41	420	—	—	—	5	—	1,135
Rye	816	460	75	135	3	—	—	6	—	1,494
Hay	540	1,300	3,500	450	3,637	430	345	309	191	10,702
Sugar Beet	—	35	23	17	7	—	—	—	—	82
Potatoes	13	15	63	19	100	48	12	11	30	321
Buckwheat	—	—	77	14	41	7	—	—	—	139

1953: TOTALS OF LIVESTOCK IN PROVINCES
(*in thousands*)

Horses	256	222	202	97	218	29	23	30	19	1,096
Milk Cows	285	289	1,040	195	1,016	95	88	94	44	3,146
Other Cattle	1,150	1,621	1,942	459	903	98	114	258	70	6,616
Sheep	170	432	414	65	361	64	95	81	39	1,721
Swine	469	1,180	1,450	287	867	56	39	42	57	4,447

A study of the preceding table shows us that Saskatchewan is much the most important of the nine provinces from the agricultural point of view. Here we find the largest areas devoted to wheat and oats, as well as to barley, flax, and rye. Alberta excels in sugar beet, which is closely connected with irrigation as we shall see. Sheep and swine are relatively dense in Alberta also. Ontario is very important as regards cattle. Quebec is of great importance for hay, potatoes, and buckwheat. The Maritimes are too small to bulk importantly in the total agriculture, while British Columbia is perhaps chiefly notable for fruit.

The map given in Fig. 120 summarizes the main features of the agriculture of the Dominion. The heavy line (labelled 'crops') bounds the agriculture on the north, and the boundary with U.S.A. limits it on the south. It is clearly a zone along the southern edge

of the Dominion in general less than 400 miles wide. The controls of croplands today are shown in a somewhat generalized fashion in the map. No agriculture at present of any note lies north of the isotherm of 59° F. for July, which is shown as a thin continuous line. It is difficult to show this in British Columbia since only the bottoms of the long north–south valleys in the south are warmer than this. But the low-lying areas shown blank in this province are for the most part warm enough in summer for agriculture.

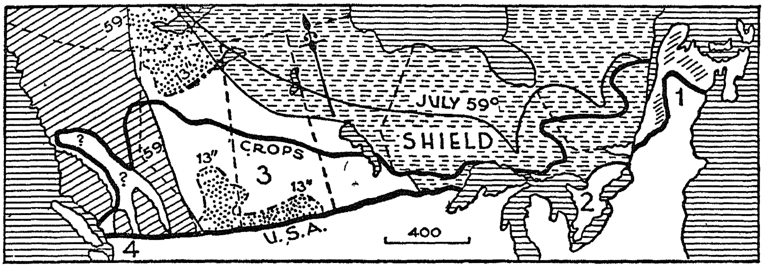


FIG. 120.—The present agricultural zone in Canada is south of the heavy line marked 'Crops'. It will long be limited by the 59° F. isotherm in July. The Shield and Rugged Mountains are indicated also

The rainfall is adequate in most of the agricultural 'zone', but the portion below 13 inches a year is shown *dotted* in the Prairies and north of them. Here also it is difficult to show the arid portions of British Columbia, since they are long narrow strips in the rain-shadows of the mountains. For this reason the sole large patches of possible agricultural land west of the Rockies are shown with query marks (?), for irrigation is quite feasible in these dry warm valleys (Fig. 120).

The third major control is of course the Shield, which is shown in the map by the dashed stippling in the north-east of the area. It is quite significant to notice that the agricultural 'zone' includes a considerable portion of the Shield in the east. Not only the Claybelts, which have already been discussed, but also large areas of rather poor-quality soils are utilized, where the pressure of population has been sufficient to justify the growth of crops close to major centres of settlement.

The mountain areas are shown approximately by the diagonal ruling. They are very extensive in the west, but are also large enough to show on this generalized map in the far east. Here the Appalachians are high enough to block close settlement in parts of eastern Quebec, and in northern New Brunswick, as is indicated.

This rough summary of the major controls is adequate to explain why Saskatchewan has today the largest amount of croplands (as is

clearly obvious in the former table), in fact nearly twice as much a either Alberta or Ontario. It is because most of Saskatchewan i free of the poor soils of the Shield, well south of the 59° F. July isotherm, and for the most part with a rainfall over 13 inches in the year. Alberta comes second in these respects, and has the second rank in agriculture. Ontario is much ahead of Quebec, since i contains a fine block of farmlands in the southern portion between Lake Huron and Lake Ontario, but it is to be expected that Manitoba will catch up in the near future (Fig. 121).

In a later section where the future of the Dominion is discussed we shall endeavour to deduce from maps akin to Fig. 120 how agriculture may be expected to spread, and to increase the population of Canada. This map (Fig. 120) also explains why it is convenient to discuss the agriculture in four major divisions (labelled 1, 2, 3, 4 on the map). In the east is division ' 1 ', which includes the Mari-

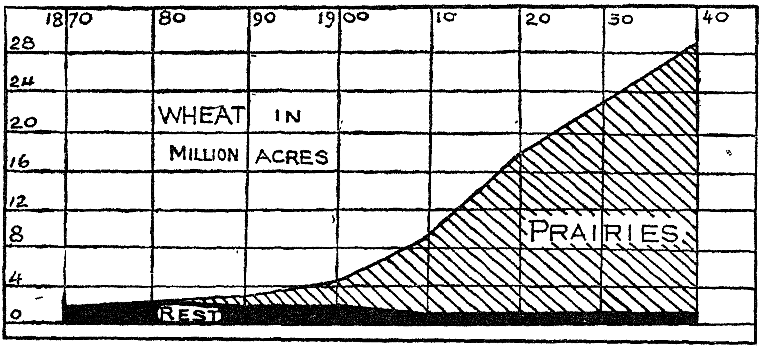


FIG. 121.—The expansion of the wheat crop up to 1940 is indicated, and also the vast importance of the Prairie Provinces

times, where the range of temperature is less than 50° F. for the most part, so that they have a *marine* climate. This agriculture is characterized by a relative importance of oats, buck-wheat, and potatoes. Division ' 2 ' includes the zone lying west of the Maritimes as far as Lake Superior. It is marked by large developments of hay, oats, and alfalfa. In Division ' 3 '—the Prairies—wheat is king, especially in Saskatchewan, where wheat is three times as widespread as oats. Here flaxseed is a noteworthy crop, and barley and rye are much more abundant than elsewhere. In the fourth division, west of the mountain divide, is British Columbia, which contains croplands only about equal to those of tiny Prince Edward Island. Its most characteristic feature is the fruit crop ; which was worth 25 million dollars in 1947. Ontario came second with 10 million dollars, and Quebec third with 2 million dollars' worth of fruit.

Agriculture in the Maritimes

The three small provinces linked as the Maritimes may well be taken together, since the three together only amount to 1·5 per cent of the area of the Dominion. Contrast this with Quebec which includes 16 per cent, or with Ontario which forms 11 per cent, and we realize what a small proportion of the Dominion is included in three out of the nine provinces. (See Recent Acreage, p. 382.)

Prince Edward Island.—We may well commence our study of Canadian agriculture with the province with the densest farming population. There are said to be 1,258,190 acres of possible farming land in the island, of which 95 per cent has been occupied. Hence there is not much room for further farms in this region. Ninety-four per cent of the farms were operated by the owners in 1931. The average size of a farm is small, being only 93 acres; of which usually about 38 acres are devoted to field crops. The following table (taken from MacArthur and Coke, *Types of Farming*, Ottawa, 1939) shows the general distribution of the crops on an average farm.

AN 'ISLAND' FARM

Crops		Stock	
1. Hay	18·3 acres	1. Horses	2·4
2. Oats	11·6 ,,	2. Cattle	7·9
3. Potatoes	4·2 ,,	3. Sheep	6·1
(Poultry, 74)		4. Swine	3·2

The type of farming is much the same throughout the island, so that no attempt has been made to differentiate the various districts in the four maps given in Fig. 122 as far as this small province is concerned. In the last thirty years there has been a tendency for sheep to diminish in importance, and for poultry to increase. There has been a great development in fox-farms, which are described elsewhere. Potatoes and turnips are often grown to furnish cash crops. It is worthy of note that Prince Edward Island as a whole forms one of the best areas in the Maritimes. Accordingly it exhibits a *dense* distribution in each of the four items (hay, oats, potatoes, and dairies) which are charted in the maps in Fig. 122.

Nova Scotia.—The earlier discussion of the general environment in this province will prepare the reader for the fact that a considerable portion of it is still almost unoccupied. This is the case with much of the central axis of the elongated territory which builds up Nova Scotia and its attendant isle of Cape Breton. Such areas are shown blank in the first map in Fig. 122. The province has a total area of

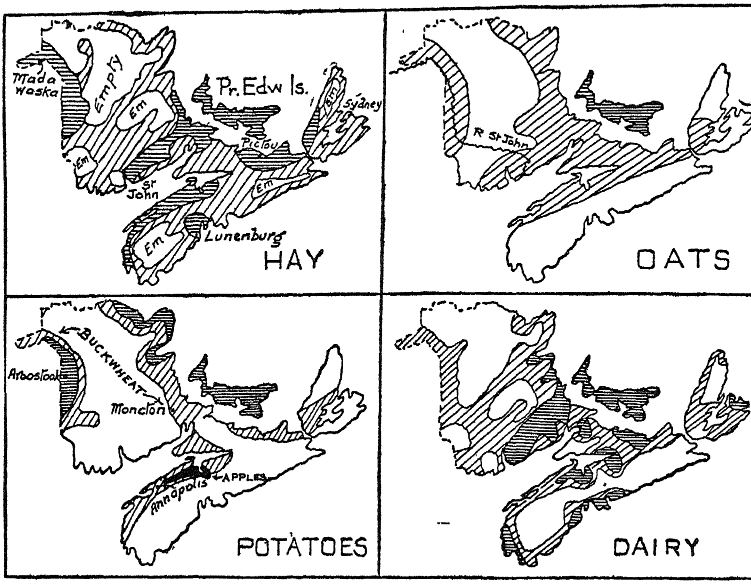


FIG. 122.—Distribution of the chief crops in the Maritimes. In the first map the areas where there are few farms are labelled 'empty'. There grades of density are charted in each map. The chief apple district in Canada is shown black. (Based on maps by D. F. Putnam, S. McArthur, and J. Coke)

about 13 million acres; but of this only about 1 million are actually cultivated.[1]

Much of the terrain is made up of ancient igneous rocks, though the borders are of younger sedimentary formations. Although all of the province is more or less covered with a layer of glacial till, yet this till is largely based on the underlying rock; so that there are poor soils over the ancient eruptives, and better soils on the margins (D. F. Putnam). Much of the soil is podsol, but there are great tidal marshes at the head of the Bay of Fundy which produce good crops of grain and hay.

The Annapolis valley is all occupied by farms, and there is close agricultural settlement in the vicinity of Yarmouth, Windsor, Amherst, and Truro. The Pre-Cambrian plateau of northern Cape Breton Island is uninhabited; but the drumlin country (based on the ancient slates) in south-west Nova Scotia—offers fairly thick glacial soils which respond to cultivation. The unoccupied portions of the province are largely forest lands, and there is still a plentiful

[1] 'Farm Distribution in Nova Scotia', by D. F. Putnam, *Economic Geography*, Worcester, 1939.

supply of wood fuel. This is extensively used in spite of the valuable coal deposits of Sydney, New Glasgow, &c.

Pasture is the most important phase of land utilization in Nova Scotia, and the area of natural pasture is about equal to that of the 'improved' farmland. Such pastures are particularly important in the vicinity of Lunenburg and Pictou. From the pamphlet on 'Types of Farming' we learn that the average acreage of a Nova Scotian farm is about 109 acres, of which 21·4 acres are improved. The average crops and stock are given in the following table.

A NOVA SCOTIAN FARM

Crops		Stock	
1. Hay	14·6 acres	1. Cattle	5·9
2. Oats 3. Potatoes 4. Barley 5. Turnips	7 "	2. Sheep	5·0
		3. Horses	1·2
		4. Swine	1·2
		5. Poultry	37

The most characteristic type of farming in the province is apple-growing, mainly in the Annapolis valley. From this area apples amounting to 5 million bushels are produced. It is also important for potatoes and for dairying, as the two maps (Fig. 122) show; but the apple crop, extending from Annapolis to the east as far as Windsor, accounts for half of the amount grown in the whole Dominion.

Dairies are widely distributed, as the map shows, but the chief centre is near Pictou, where milk is collected for the use of the large coal-mining population nearby, as well as for the citizens of Halifax to the south. So also the coal-mines of Sydney have led to the growth of a large milk trade in the vicinity of that town. Putnam describes the economy of the fairly dense population which lives along the southern shore of the province between Halifax and Yarmouth. Here fishing is the chief industry, but every family has a garden or small farm, consisting of a potato patch and a few acres for the subsistence of a cow. As in Prince Edward Island there are many fox farms, the number being 566 in 1930.

New Brunswick.—In the early days of settlement New Brunswick was noted for its potatoes and its wheat. But with the development of the prairie wheatfields, the growth of winter wheat in the Maritimes has diminished greatly. As the preceding table (p. 382) shows, wheat is now negligible in comparison with oats. However, the province contains near Aroostook one of the chief districts in the Dominion for potatoes (Fig. 122). About 1·5 million acres of the Province

are 'improved', out of a total of 4 million. The average size of a farm is about 122 acres, but a large part of this remains as woodland, for the field crops on a farm only average 28 acres. The constitution of such a small farm is as follows:

A NEW BRUNSWICK FARM

Crops		Stock	
1. Hay	17·4 acres	1. Cattle	6·4
2. Oats	6·4 ,,	2. Sheep	4·2
3. Potatoes	1·8 ,,	3. Horses	1·6
4. Buckwheat	1·2 ,,	4. Swine	2·6
		5. Poultry	44

It is of interest that the numbers of cattle, sheep, and swine per farm were higher in 1861 than they were in 1931 (McArthur and Coke).

In a paper illustrated by a number of maps and photographs D. F. Putnam has discussed the 'Agricultural Development of New Brunswick' (*Economic Geography*, 1939). He points out that the soils over the Carboniferous sandstones of the middle and east of the province are quite poor, but that the limestones of the north-west give rise to richer soils. There is a fairly deep layer of till over most of the province, while the coasts show marine deposits indicating considerable relative movement of the shore-lines.

Putnam points out that over half the total area is quite empty, and still remains in the hands of the Crown. These empty areas are shown on the first map in Fig. 122, and some of them formerly had a measure of settlement, but the folk have abandoned their farms. Field crops occupy 960,000 acres, i.e. about 72 per cent of the improved land, or 23 per cent of the total farmland. A reference to the main table of crops (p. 382) shows that 62 per cent of the acreage is devoted to *hay*, with the chief concentration in the St. John valley along the western border (Fig. 122). Another important area for hay is in the vicinity of Moncton, where indeed there are not so many crop rivals, so that timothy and clover hay are of prime importance.

About 23 per cent of the crop-land consists of *oats*, which are also charted in one of the maps in Fig. 122. Here again the densest crop is found in the St. John valley, where about 15 per cent of the farmland is thus utilized. Potatoes are quite important, and 122,000 acres of this product were grown in 1942. As mentioned, the district near Aroostook in the west has always been famous for potatoes, which are also grown in large amounts in adjacent districts of U.S.A. Along the shore of the Bay of Chaleur is another district

of considerable importance, as the map shows. *Buckwheat* is much more important here than in the other two Maritime provinces. The chief centre is in Madawaska county in the north-west, where there were 9,000 acres devoted to this crop in 1931. Second in rank to the upper valley of the St. John is the region north and west of Moncton.

Dairy products amount to about 5 million dollars annually, and are definitely concentrated along the roads leading from St. John to Moncton. These large towns need much milk, and there are many butter and cheese factories in this district. *Hogs* are raised in considerable numbers near Moncton, while there is a noteworthy growth of *apples* in the lower St. John valley. *Poultry* are also more abundant in this area than in other parts of the province. The counties along the northern and south-west fringes of the province are still in a somewhat pioneer stage, with settlements being cut out of the coniferous forest. Here sheep are of some little importance and they are also grazed in Kent county north of Moncton.

Agriculture in Quebec

A useful summary of the state of agriculture in this province is given in the bulletin by McArthur and Coke,[1] and it forms the basis of the following account. Agriculture in the province commenced in 1608, when 28 settlers spent the winter at Quebec. But progress was very slow, and by 1667 less than 10,000 acres were under cultivation. Two centuries later in 1844 there were 114,496 farms in this province, and there has not been much change in these figures in the last century, for in 1931 the figure was 135,957.

Changes in the condition of the people have been marked in Quebec as in other parts of Canada. For instance, in 1871 the rural population formed 77·2 per cent of the whole, whereas by 1931 the proportion had fallen to 36·9 per cent. The area of occupied farmland in the latter year was 17 million acres, of which just half were 'improved'.

The average size of a farm in 1931 was 127 acres, of which 66·1 acres were improved. The area devoted to field crops averaged 44·7 acres per farm. There has been a considerable shift in the importance of certain crops. For instance, since the development of the Prairies, wheat has declined in Quebec from 240,000 acres in 1870 to less than 40,000 by 1931. The table on p. 390 shows the character of an average small farm.

From the preceding descriptions of the climate and soils of Quebec, it will be evident that only a small portion of this huge province is of agricultural value. Thus only about 10,000 square

Types of Farming in Canada, Dept. of Agriculture, Ottawa, 1939.

A QUEBEC FARM

Crops		Stock	
Total field crops	44·7 acres	Cattle	12·8 head
Oats	12·2 ,,	Sheep	5·4 ,,
Cultivated hay	27·7 ,,	Swine	5·5 ,,
Potatoes	1 ,,	Horses	2·4 ,,

miles out of 523,000 square miles are settled; and there does not appear to be any hope of close settlement north of the 59° F. summer isotherm (Fig. 120).

The best lands, as already described, are those bordering the valley of the St. Lawrence (Fig. 46). Here are formations which are younger than the Shield, thus yielding better soils. But the best land is where the 'Champlain Sea' formerly extended over the continent in the last phase of the Ice Age. (See Recent Acreage, p. 382.) This is discussed on p. 126. However, the southern portion of the Shield varies in fertility in a remarkable degree. For instance, there is the eastern extension of the Great Clay Belt (Fig. 79), which produces much fair to poor agricultural land in the Abitibi district. Indeed, since this part of the clay belt is somewhat less uniform, with gravel beds intermingled with (and below) the heavy glacial clay, its natural drainage is on the whole better than that of the clays in Ontario. For this reason the Quebec moiety of the Clay Belt is somewhat more satisfactory for farming over considerable areas.

The region round Lake St. Jean at the head of the Saguenay has been described earlier (Fig. 50). It is a *graben* which includes large areas of fair soil, though it is completely surrounded by the sterile granites of the Shield. It seems quite likely that a number of other smaller depressions with somewhat better soils, fringing the northern shores of the St. Lawrence, may be identified in the future. The topography of the Gaspé Peninsula prevents any notable agriculture on the northern shore, while the southern shore, though fairly flat, seems to consist of rather sterile soils. It is still somewhat of a pioneer region after 300 years of settlement, with scattered farms devoted to a little dairying, with some sheep and poultry, and potatoes for the main crop. As stated earlier, this corner of Quebec has the low July temperature of 61° F.—not very different from that found near the Arctic Circle in the Mackenzie valley in the same month (p. 58).

The total values of agricultural production in Quebec for 1942 were as follows:

AGRICULTURE IN 1942

Field crops	$145,000,000	1. Hay	$76,000,000
		2. Oats	26,000,000
		3. Potatoes	17,400,000
		4. Mixed grains	6,000,000
		5. Barley	2,700,000
		6. Peas	1,500,000
		7. Buckwheat	1,300,000
		8. Wheat	532,000
Farm animals	60,000,000		
Milk	78,000,000		
Fruit	12,000,000		
Poultry	19,000,000		
Maple sugar	5,000,000		
Total (with other products)	$325,567,000		

It is clear from this table, and from that given on p. 382, that the geographer's chief interest in this province will be in hay, oats, and potatoes, with some discussion of the livestock.

The *oats* crop in Quebec is widespread wherever there are farms, as may be seen from the first map in Fig. 123. Here the limits of notable agriculture are based on the maps by McArthur and Coke. The development of the new lands along the National Railway near Senneterre and Abitibi is indicated in the first map. The isolated district of Lake St. Jean is also marked in this same map. As far as the writer is aware no detailed crop or stock charts have been made by the Quebec geographers, so that the data for this province given on Fig. 123 are less accurate than for the others.[1]

Since the oats crop is grown largely for feeding to livestock, it does not enter into commercial channels to anything like the same extent as wheat. In Quebec there is a concentration of this grain in the districts near Montreal, especially to the south of the city. Much is grown near Lake St. Jean, while the Matane coast and the lower Ottawa River region are perhaps somewhat above the average density. As we should expect, where oats is grown as a cash crop, it is found farther north than the districts where wheat is grown.

The *hay* crop in Quebec, as in other provinces, consists partly of wild hay and partly of cultivated grasses. The most popular type of hay in Canada is a mixture of timothy grass and clover. In 1930 no less than 70 per cent of the hay was such a mixture. Alfalfa is increasing in importance, especially to the south and east of Montreal. The cutting of clover and grasses for *seed* is widespread

[1] A general discussion of Quebec Agriculture (without crop maps) has recently been published in Montreal (1943, Editions Fides).

in the province, especially in the counties of Soulanges and Vaudreuil. The second map in Fig. 123 shows this concentration of the hay crop in the south, in part linked with the abundance of dairies hereabouts for the supply of milk to the huge population of Montreal.

Buckwheat in 1941 occupied 122,000 acres, or nearly 6 per cent of the croplands. It is the fruit of one of the *Polygonaceae*; and has no resemblance to wheat, either as regards plant or grain. It is one of the best crops for very poor, badly tilled land; and provides an abundant source of honey in bee-farming. In Canada the fruits (shaped like beech-nuts, hence the name) are grown chiefly as poultry

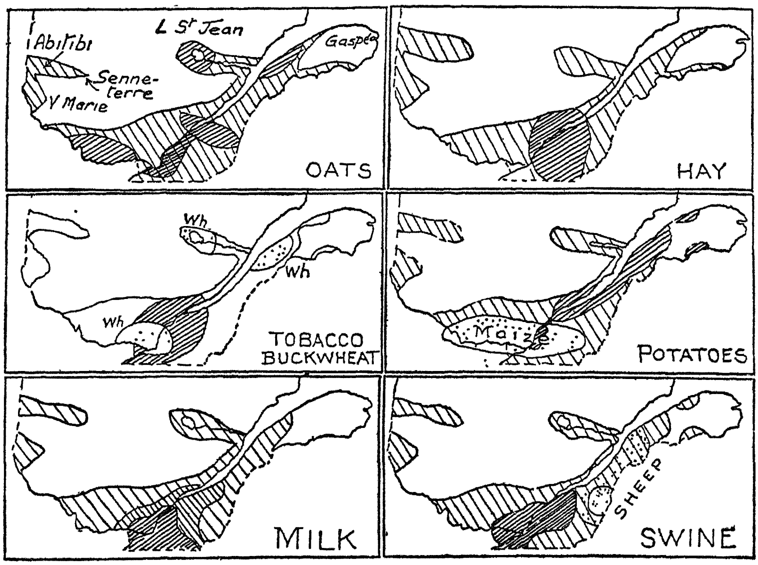


FIG. 123.—Distribution of crops and stock in Quebec, all the maps being somewhat generalized. Wh. means buckwheat

feed, but it is often eaten in the form of pancakes by Canadians. Some buckwheat is grown throughout the agricultural areas, but the chief crop is found in the vicinity of Quebec and Montreal (Fig. 123).

Tobacco is grown almost wholly in Quebec and Ontario among the nine provinces. In Quebec its chief area is the north shore of the St. Lawrence to the east of Montreal, but there is a large area of tobacco on the south shore also, as is indicated in Fig. 123. In this province the tobacco is chiefly of the dark or Burley type. About 14,000 acres are devoted to this crop. The later manufacture of tobacco employs many hands in Montreal and Quebec, where the crop from Ontario (Essex county, &c.) is also processed.

Potatoes are the most profitable crop in the colder bleak portions of settled Quebec, as mentioned in the description of Gaspé. But the crop, though spread throughout the farmlands, is most concentrated near the city of Montreal, as the map (Fig. 123) shows.

Maize (corn) is grown for fodder in all the provinces, and in Quebec the climate is too cold for the husks to ripen on most of the farms. There is a considerable amount of maize grown in the south of the province, mostly at the lower end of the Ottawa River, and south of Montreal.

Quebec is of small importance as regards beef cattle, but the number of *dairy* cattle is high, as is clear from the table on p. 382. The distribution is charted in Fig. 123, and the main concentration is seen to be around Montreal and in the adjacent counties to the south. Indeed, the whole of the Eastern Townships is important in this respect. Milk used for cheese manufacture is generally produced during the summer months, and the abundance of rough pasture in this area lends itself to dairying of this type (McArthur).

Sheep are not very important in Quebec, but there is an area of dense sheep on the flanks of the Appalachians, as appears in the map, where the chief sheep districts are indicated by dots. The raising of *hogs* is fairly general in all farms, but is becoming more important in the districts south of the cities of Montreal and Three Rivers. Here as usual hog-raising is associated with the dairying industry and the production of skim milk, which is fed to the hogs. This is also the region where the most corn is grown.

Agriculture in Ontario

A glance at the map given in Fig. 120 will show that only the southern portion of Ontario produces much in the way of agricultural products, though the Clay Belt, discussed elsewhere (p. 217), is of great interest as a pioneer region of some future importance. Hence in this discussion of the crops the attention of the reader will be focused on the agriculture in the region south of the Shield. This region of younger formations is broken by the extension of the Shield called the ' Frontenac Axis ', which interposes a belt of poor granite country, studded with small lakes, between the farmlands south of Ottawa, and those of the main portion of southern Ontario (see Fig. 124 at ' 1 ').

The area under consideration is about 400 miles long and 200 miles broad, so that it is about the same size as Britain south of the Grampians. In the 16 maps which follow, the author has endeavoured to show the chief controls which determine the distribution of the crops, as well as the crops themselves as they were harvested in the autumn of 1936. This study is based on my article which appeared in *Economic Geography* (Worcester, Mass.) in January 1938.

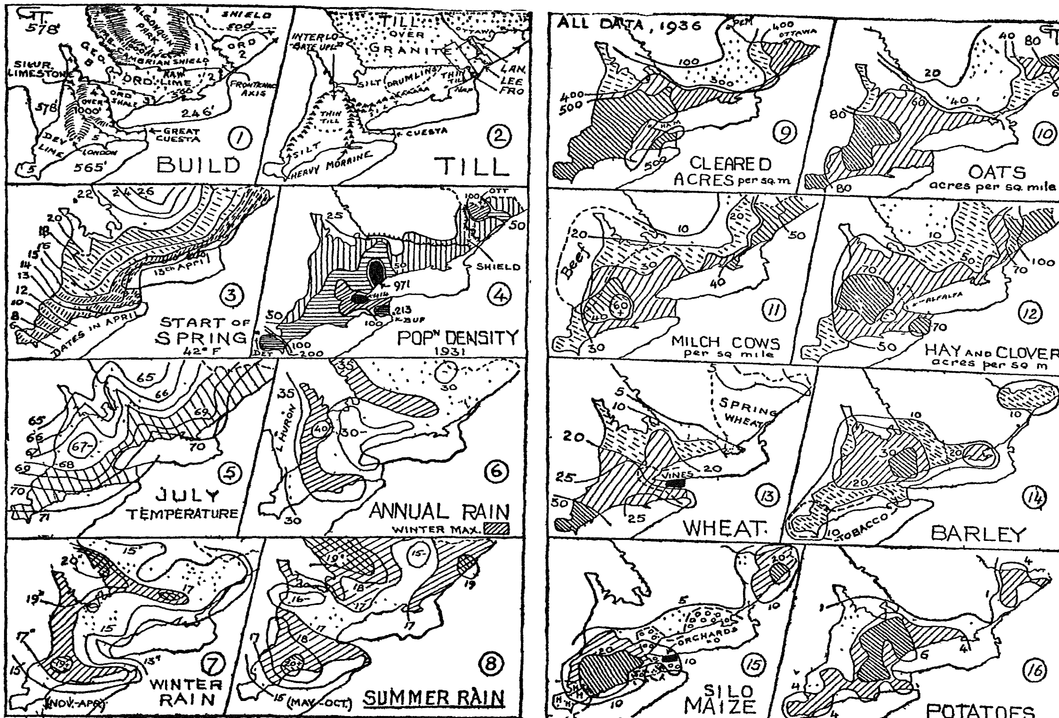


FIG. 124.—Crop isopleths for southern Ontario in 1936. The climatic data are *normals* based on lengthy records. (*Economic Geog.*, 1938)

In the climatic maps the data are based on the averages for forty stations recorded during twenty or more years.

The crop results are shown as ' Acres Sown ', which do not vary so much as do the data for ' Bushels Harvested '. Grain crops in 1936 were rather poor for areas near Lake Ontario and Lake Erie, but the *distribution* pattern of the crops, which is the chief matter of interest to the geographer, was not much affected. The average harvest for the ten years 1925–34 was 156 million bushels, whereas in 1936 it reached only 127 million bushels. (See Recent Crops, p. 382.)

The following table shows the order of importance of crops in 1937, based on a total farm value of 144 million dollars.

RELATIVE IMPORTANCE OF CROPS IN ONTARIO, 1937

1. Hay and clover	23 per cent	6. Alfalfa	8 per cent
2. Oats	21 ,, ,,	7. Barley	7 ,, ,,
3. Wheat	14 ,, ,,	8. Potatoes	4 ,, ,,
4. Mixed grain	10 ,, ,,	9. Turnips	3·5 ,, ,,
5. Maize	9 ,, ,,		
		Total	100 = $144 million

In the accompanying maps (Fig. 124) the first shows the main features of the topography. This has been discussed in a general fashion on pp. 137–45; so that here it may be noted that only two areas are above 1,000 feet, Algonquin Park in the north, and an area to the west of the great Cuesta. Lake Ontario is 246 feet above sea level, and the chief low-lying districts in our area are near Kawartha Lakes (KAW in the map) and to the west of London.

In the second map (Fig. 124) some of the variations in the surface soils are indicated. Glacial till is universal, and the underlying rock is rarely visible except along the Cuesta, and in the east near Napanee (NAP). The till is thickest in the ' Heavy Moraines ', which radiate in three directions from near Orangeville. On the margins of the Great Lakes are extensive deposits of lake silt resulting from former small glacial lakes. The Drumlins are especially noticeable in the north centre. This covering of till varies in soil values according to the underlying rock, as has been explained in an earlier section (p. 140).

The first climatic map (3) shows the ' Start of Spring '. In most plants vigorous growth begins when a temperature of 42° F. is reached. The isopleths on the map show the day when this average temperature is recorded. In southern Ontario near Windsor this occurs about April 6th, while in Algonquin Park in the north the same temperature is not reached until April 26th. Thus the spring

moves north at the rate of about 15 miles per day; and at any given place the temperature rises about four-tenths of a degree each day.

The second climatic map (5) shows the July isotherms (not reduced to sea level), and it is worth noticing that the counties of Essex and Kent in the far south-west are considerably warmer than the rest of Ontario. The average for the three warmest months, which is vital for most crops, is usually *two degrees less* than the average in July. As regards rainfall, the variation in time and place throughout southern Ontario is not very large. However, the *Winter Rain* map (7) shows a well-defined area of heavier rain along the Huron coast, with a 'wet loop' across the 'Kawartha Depression', and also across the London gap. The driest district is in the shadow of the Cuesta, while the wettest areas are in the west near Parry Sound and London. This is perhaps due to the effect of Lake Huron on the westerly winds of winter. In *summer* the rain is partly due to convection, and is more patchy; while the *annual* rain map seems to agree pretty closely with the distribution of the winter rain. Again we see the influence of Lake Huron, for in general in East Canada the rains become heavier as we move *east* to the Atlantic.

Factors controlling the Crop Isopleths

The outstanding feature in all the crop maps is the negative loop (i.e. with few crops) extending to the south-east down the Frontenac Axis (Fig. 124). This loop is apparent in all the maps, though to a less degree in that for Hay than in the others. Since temperature and rain maps show no similar loops, we deduce that the presence or absence of the *sterile soils* based on the Shield is the chief control.

In map '9' the number of acres of *Cleared Land* in each county is charted. A total of 640 *acres per square mile* would mean that every acre in the county was cleared. This is nearly true of Kent and Perth in the far south-west, where about 550 acres have been cleared in each square mile. There is an interesting belt of 'slightly cleared' land to the south-west of Hamilton. This is in part due to the thick gravelly moraines in that area. The Frontenac Axis, and the line of the Cuesta, extending as Bruce Peninsula into Lake Huron (map '1') also account for smaller proportions of cleared land.

In map '10' (Fig. 124) the distribution of the chief grain crop, that of *oats*, is charted. Here again we see the influence of the Frontenac Axis. The optimum for oats runs along the middle of the agricultural belt. This would indicate that a July temperature around 68° F. or 69° F. is of more importance than the distribution of rainfall, which is probably adequate throughout southern Ontario.

In map '12' is plotted the largest crop in the province, that of *hay and clover*. The agreement with oats is quite close, and the

map showing the distribution of *milch cows* (11) has similar isopleths. Here again there are two centres, one near London, and another near Ottawa. The chief region for *beef cattle* is along the Huron shore, and it is shown on the map. None of the crops so far noted is very densely represented near Toronto.

The *wheat* map shows a very different distribution. Only in the extreme south-west is wheat important; and indeed in Kent it exceeds oats in abundance. Obviously the higher temperatures in this corner of Ontario are the deciding factors. About 85 per cent of the whole area is fall wheat, while 15 per cent is spring wheat. The latter is grown in the far east, where the winter temperatures (and the range of temperatures) are much more extreme than in the south-west.

Barley (map '14' in Fig. 124) shows the usual separation into two areas by the Frontenac Axis, but here the optimum is concentrated around the capital. As in Australia, this is probably due to the capital being the site of a brewing industry, rather than to any special physical advantages for the growing of barley near Toronto. So also *potatoes* (map '16') are grown mainly near the large centres of population. This is partly due to the fact that potatoes bruise very readily, and so cannot be carried so far to market.

Maize is clearly concentrated on the warm southern fringe of the province, and it requires a higher temperature than wheat or oats. Most of the crop is cut green and used in siloes, but in the south-west near Windsor there is a good deal of corn grown for husking. No maize of importance is grown north of the July isotherm of 68° F.

There remain for consideration four special crops, i.e. fruit, tobacco, vines, and alfalfa. In the two former the sheltered shore of Lake Ontario to the north of the Niagara Cuesta is specially favoured. Very few vineyards are found far from this chosen district in Lincoln county (map '13'). *Alfalfa* (i.e. lucerne) has somewhat the same distribution as is seen in map '12'. Orchards extend along the lakes, from Aylmer in the west to Kingston in the east. *Tobacco* is grown only in the hottest part of the province, which is clearly the north coast of Lake Erie. Here also the soils are especially favourable for this crop (see map '14' in Fig. 124).

Agriculture in the Prairie Provinces

In earlier chapters the isolation of the prairie provinces from the rest of the Dominion has been pointed out. Structurally, they form the major portion of the southern part of the *Downfold* between the Shield and the Young Mountains of the west. Geologically, they consist of relatively young deposits overlying the Shield; for the most part Cretaceous and Tertiary, but with a broad selvage of early

Paleozoic formations near the eastern limits. However, a thick layer of glacial *till* covers the whole area, and there is no large ' Driftless Area ' as in the United States to the south, which has been missed by the widespread lobes of ice.

Between the agricultural lands of the Prairies and the older settlements of the east is the huge area of the Shield, which borders Lake Superior and Lake Huron on the north. Here the soil is poor and thin except in the Clay Belt, but there are innumerable ' pockets ' of slightly better soil, which will become of more value as the better lands to the south are completely exploited. However, in the whole of western Ontario, from Lake Simcoe to the western border, there is very little, if any, first-class agricultural land. So also the agricultural plains cease abruptly at the Rockies, whose eastern border is rather definite, since it is due to the front of an overfold along considerable distances (p. 169). The northern edge of the prairie croplands is of course ill-defined, especially in the west, and offers to the Canadian the largest areas of second- and third-class land left to the future settler.

Turning to the drainage systems, the vast body of the Prairies belongs to the Saskatchewan basin, whose rivers ultimately flow into the Nelson and so reach Hudson Bay. But just to the north of Edmonton is the divide between this basin and that of the Peace-Athabasca-Mackenzie basin, whose waters flow northwards to the Arctic Ocean. Almost all of the agriculture of to-day is in the Saskatchewan basin, though the new ' Peace River area ' belongs to the northern basin.

The standard volume dealing with the environment and agriculture of this part of the Dominion is *Prairie Settlement*, by W. A. Mackintosh (Toronto, 1934). The present writer, early in his study of Canadian Geography, came to the conclusion that this was the most valuable contribution to that study which has yet been published; and he makes considerable use of it in this chapter. It is based essentially on the study of isopleth maps, and is thus far ahead of many of the contemporary studies of geography in the east, where maps of this kind are sadly lacking.

Since this region will always be the granary of Canada, and to some extent of the Empire, some reference to the early forecasts as to its possibilities are of interest (Fig. 126). They are based on the chapter in the above volume entitled ' Agricultural Exploration '. In the early days, as noted previously, the Red River area of Canada was in touch with the ' outside ' primarily by way of St. Paul in U.S.A. Regular trains of Red River carts moved to that town as early as 1844. Steamboat navigation on the Red River began in 1859, and Minnesota built its first railway in 1862. About the time of the transfer of the territory to the Canadian Government from

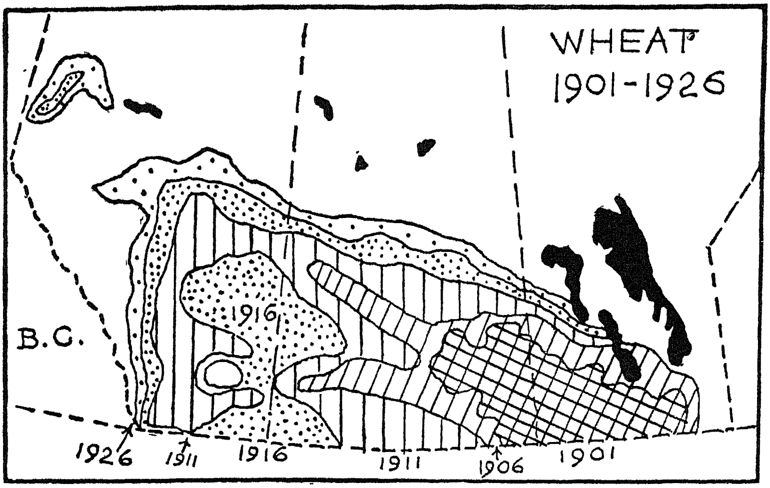


FIG. 125.—The most vital period in the expansion of Canadian wheat, from 1901 to 1926. (From the *Statistical Atlas*, Ottawa, 1931)

the Hudson's Bay Company, several expeditions under scientific leaders were sent into the Prairies.

Sir George Simpson in 1857 was of the opinion that no part of the vast prairie lands of the Company was suitable for close settlement. He thought the scarcity of fuel a great handicap, that the soils were inferior, and that the climate was such as to give very uncertain crops. Richardson the explorer laid stress on the great difficulties of transport, which undoubtedly are the great handicap in any pioneer community based on agriculture. On the other hand, another explorer, Richard King, stated that the lands south of Lake Athabasca were arable, while the Great Fish River basin far to the north was 'the finest grazing country in the world'. He is thus in line with the optimists of 1946, for these regions have not yet been settled to any notable degree!

Captain Palliser was sent out by the Colonial Office in London, and was busy from 1857 to 1860 in a survey of much of the prairie region. He divided it, on an ecological basis, into the northern 'fertile belt' and a southern 'semi-arid desert'. He wisely charted some of his data, and 'Palliser's triangle' includes that portion which he considered unfit for close settlement. It is interesting to see how actual settlement in the succeeding ninety years agrees with his forecasts (Fig. 126). The area which received less than two people per square mile by 1931 is shown by the *dots*, while the regions with more than 10 per square mile are shown by the close *diagonal ruling*. It will be granted that Palliser's 'triangle' includes

all the poor southern country, while that found to be best suited for settlement is entirely to the north of his line.

Another more detailed forecast was made about 1880, based largely on the surveys of the botanist Professor John Macoun. He objected to Palliser's findings in some respects, especially regarding the northern portion of the prairie, where the buffalo found good grazing. He allowed only 20,000 square miles for the *arid* country, and believed that there were 150 million acres of land fit for agriculture or pasture in the Prairies. (Some 50 years later, 9 million acres had been occupied and improved.) Macoun is to be commended for his study of the northern sweep of the summer isotherms, of the uniform type of flora, and of the opening of spring; all of which are still recognized as invaluable criteria in deducing

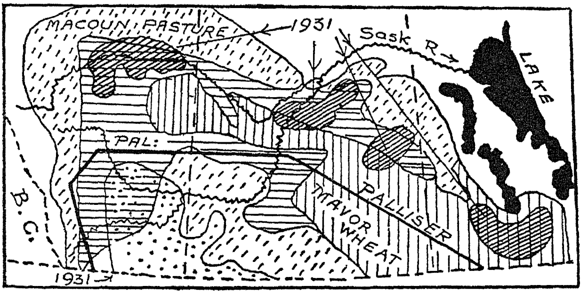


FIG. 126.—Forecasts as to the future of the Prairies. Palliser's 'Triangle' is indicated by the heavy line; Mavor's 'Pastoral Lands' by dashes, and his Wheat lands by open ruling. The actual results in 1931 are indicated by close ruling for *dense* settlement, and by dots for *sparse* settlement. Probably more significant is the warm 'triangle' shown in Fig. 21

the possibilities of the far northern districts of the Dominion for crops.

Around 1904 Professor James Mavor made a report on the relative values of various portions of the Prairies. His conclusions are charted in Fig. 126. He thought that some 22 million acres might be devoted to wheat—mostly in the central belt (ruled vertically in Fig. 126). (The census of 1926 reported exactly this amount under wheat.) About the same time Dr. Charles Saunders, who originated 'Marquis' wheat, forecasted that 800 million bushels of wheat would yet be produced, and this is now felt not to be too visionary a forecast.

Distribution of Wheat in the Prairies

The overwhelming importance of the prairie provinces as regards the production of Canada's main crop can best be seen from the graphs shown in Fig. 121. This clearly demonstrates that in the

remainder of the Dominion the wheat crop has actually decreased in importance since about 1890, when the prairies first began to be large contributors. Today the prairie harvest is about 27 million acres, while the rest of Canada only amounts to about 1 million acres.

It is interesting to look back to 1876 when the region around Winnipeg included about 15,000 acres of wheat. By 1901 most of the wheatlands of Manitoba were being farmed, as is evident from the isopleths in Fig. 125. But since that date this portion of the Prairies has produced vastly greater yields in this same area. From 1901 to 1906 the harvest spread to southern Saskatchewan, the two 'tongues' of wheatland clearly representing farms occupied

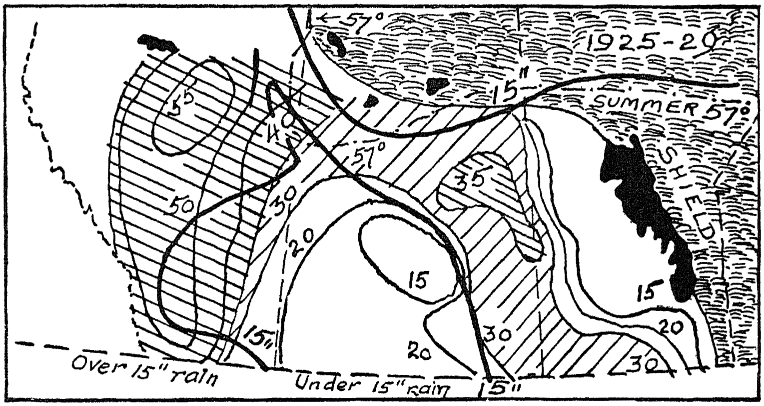


FIG. 126A.—Yields of wheat (bushels per acre) for five years. Note relation to 15-inch rainfall shown by heavy lines

along the chief railway lines. By the end of 1911 the best wheat areas of Canada had been sparsely occupied, though much close settlement is found in these wheatlands today. The less attractive lands along the Alberta-Saskatchewan border were taken up during the next five years; and this area is shown *dotted* in Fig. 125. Not much change in the distribution occurred by 1926, though there was a slight spread to the north-west, and the Peace River area was attracting wheat farmers. The distribution twenty years later (in 1945) is not very different from the final isopleth of 1926 on Fig. 125.

During the later years of the prairie harvests the yields per acre have greatly increased, largely owing to the use of the tractor, combine, and other machinery. But there is considerable variation in the three provinces. Wheat is of less relative as well as absolute importance in Manitoba, where the oats crop occupies as many acres. In Alberta wheat has twice the importance of oats, while in Saskatchewan wheat covers three times the acreage.

Wheat is a cereal which can grow with a rather low total rainfall, especially if the rain falls mainly in the growing season, and if the period of harvest is fairly dry. The controls of the wheat crop are indicated in Fig. 126A. Here the average yield (in bushels per acre) is charted for the five years 1925 to 1929. The best yield is seen to be in Alberta in the vicinity of Edmonton. Here conditions seem to suit wheat better than near Winnipeg, which is a much older wheat area (Fig. 125). The course of the 15-inch isohyet is approximately plotted in Fig. 126A, and it will be seen that the best wheat yields occur in the crescent belt where the rain is over 15 inches a year. The north-east of the region given in Fig. 126A is not likely to produce wheat, since the dominant control here is the granite of the Shield. So also the temperature conditions are unfavourable in this corner, since the average summer temperature falls below 57° F. (This last isotherm is charted.)

However, it is to be realized that the variability of the rainfall is rather high in the region of southern Alberta (Fig. 27); and the farmer has to face this risk among the many others of his vocation.[1] A quotation from the official Atlas emphasizes some of these factors in the wheat problem.

> Up to the present wheat has proved the best cash crop in the Canadian West. The relative shortage of labour and capital, the elaborate organization for storing, transporting and financing the marketing of this product, the comparative stability of prices as compared with livestock, and the general high level of return per acre attendant on an expanding world demand, have combined to bring about a high degree of specialization in the production of this cereal. However, as agriculture passes through the pioneer stage, a more permanent type of farming is established, and wheat becomes relatively less important in the farm economy. This transition is already under way in some of the older parts of the Park Belt in Manitoba. The future of wheat production in the arid districts is by no means definitely established.

Varieties of Wheat and their Distribution

Wheat is so important a crop that a brief description of the chief varieties grown in the province of Saskatchewan should prove of value. There are half a dozen varieties recommended by the Department of Agriculture, but three of these are pre-eminent.[2] Their distribution depends mainly on the soil and climate of the various portions of the wheat belt in this province. Three belts

[1] The problems of soil erosion, &c., in the drier parts of the Prairies are discussed by Archibald and Dickson in an interesting article in the *Canadian Geographical Journal* for February 1944.

[2] For an interesting account of wheat breeding see the articles by L. H. Newman in the *Canadian Geographical Journal* for April 1939.

may be noted, with the usual north-west to south-east axis in each case. These are the South-west Belt with brown soils; the Central Belt, mostly with dark brown soils; and the Northern Belt where the black soils merge into the grey soils. (Fig. 35.)

In the Northern Belt the variety known as *Reward* is the best to plant. It is a beardless variety with short irregular heads and white hairy glumes, and has a high protein content. It is ripe 4 to 6 days earlier than Marquis, and is less rust-susceptible, but yields less than Marquis.

In the Central Belt *Thatcher* is preferable in general. It is a new highly rust-resistant beardless variety. It matures 2 to 4 days earlier than Marquis. Under conditions of rust epidemic it yields much higher than Reward or Marquis, and in milling and baking quality it is equal to Marquis.

In the South-west Belt *Marquis* is the preferred wheat, and is still the principal variety grown in Saskatchewan. It is early maturing and yields well, and is highly resistant to shattering, but it is rather susceptible to stem rust. It is specially recommended for the drier portions of Saskatchewan.

Durum or macaroni wheats are more susceptible to stem rusts and to smuts, and are also less drought-resisting and mature later. They are grown chiefly in the wetter southern portions of Manitoba, and farmers are especially warned not to mix them with other types of wheat.

Oats and other Prairie Crops

Second only to wheat in Saskatchewan and Alberta, and about equal in importance in Manitoba, the oat crop is shown in the second of the maps in Fig. 127. The distribution is somewhat the same as in the case of wheat (though in detail oats and wheat alternate in neighbouring districts), with maxima south of Edmonton and south-west of Winnipeg. There is, however, a well-marked concentration of oats in southern Saskatchewan, which is lacking in the wheat crop. Oats extends rather farther to the cool north, as we should expect, especially in the Peace River area. In Alberta the first form of settlement was rather of the ranching type, where oats was a more important fodder crop than wheat, but in recent years with the increase of small holdings, and with farmers replacing ranchers, the wheat crop is much more important than oats. *Banner* and *Victory* have been the leading varieties in most of the prairie farms, especially in Saskatchewan. Both are high in yield, medium late in maturing, and are moderately strong strawed.

In 1936 oat production was reported by 69 per cent of all farms, and its acreage occupied 20·2 per cent of the total crops. In general oats mature somewhat earlier than wheat, but this crop does not

resist drought so well. Since oats are largely grown for livestock the crop is found growing where the farmer goes in most strongly for cattle and sheep.

Barley is of much less significance, occupying in 1936 only 8 per cent of the crop acreage (Fig. 127). There are three districts where barley is concentrated, as appears in the map. They are Portage (Manitoba), Melfort (Saskatchewan), and south of Edmonton (Alberta). In recent years in Manitoba the wheat has suffered

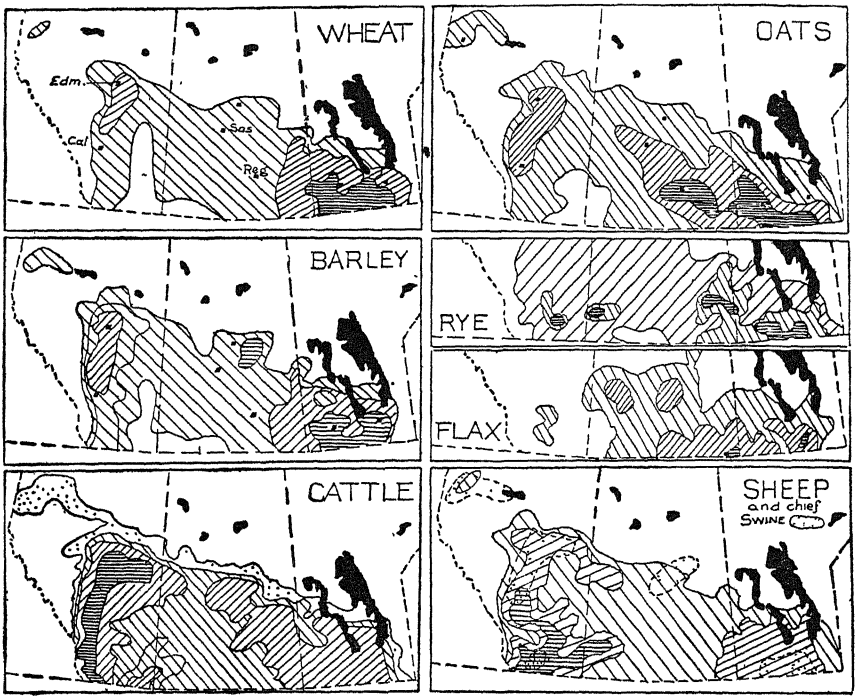


FIG. 127.—Distributions of crops and stock in the Prairie Provinces. Based on maps in the *Prairie Atlas*, 1931, and *Prairie Farming Census*, 1938. The ruling indicates approximately the densities

greatly from rust; hence there has been somewhat of a shift to barley, which is less susceptible to this pest.

Rye is not grown extensively in the west, since only about 5 per cent of the farms report it, and the total crop is little over 1 per cent in the prairie farms (Fig. 127). It is grown in the southern portions, to a considerable extent in the dry south-west as the map shows in Fig. 127. Rye is generally planted in the fall, and does not suffer much from the cold winter. There is little rye grown in the other parts of Canada.

Flax chiefly comes from Saskatchewan, where it was found to be a very useful crop on the first breaking of the ground. The crop is mainly grown for the seed, very little use being made of the fibre (Fig. 127). *Redwing* and *Bison* are the two varieties which are most popular. The former matures earlier, but is lower in oil yield and has a shorter straw.

A few words on the topic of introduced grasses and forage crops will be of interest. Many of these grasses, such as Western Rye, Brome, and Crested Wheat Grass, are quite drought-resistant, and stand the continental winter. Their yields of hay agree very closely with the amount of rainfall. *Alfalfa* is well adapted to the black and grey soil zones, but like all the allied crops it is relatively unproductive in the high lands in the brown soil region. It is somewhat susceptible to winter cold, unless it has some eight inches of growth. A considerable area around White Fox (Saskatchewan) is devoted to the growth of alfalfa for purposes of seed. This is also a paying industry in the irrigation areas of the south-west. It is worth noting that a large oats crop is grown primarily to produce *hay*, especially in the north-east section of Saskatchewan. *Potatoes* are grown widely throughout the Prairies with a marked concentration around Winnipeg and Edmonton. Early Ohio and Irish Cobbler are the most popular varieties.

Livestock on the Prairies

When the buffalo was killed off, his place was taken by the livestock of the early settler. Although the open range has naturally been much reduced in area as settlement progressed, the number of stock has in general increased considerably. This has been possible owing to the great increase in the growth of fodder crops. As the settlers have pushed north into the Park Belt, there has been a shift from ranching in the direction of dairying (Fig. 127).

In 1936 cattle were reported by 81·4 per cent of the farms, and the concentration is heaviest in the dark brown and black soil regions, and in the foothills of Alberta. Ranching is also important in the rather dry country on the boundary of Alberta and Saskatchewan. The proportion of milch cows has been steadily rising, especially in the two western provinces. The relative numbers in the prairie provinces are given in the table on p. 382.

In many of the farms a mixed economy is practised, based on cattle, hogs, and wheat; as for instance in the Macleod district in south-west Alberta. So also in the new Peace River area in the north-west of this province the same mixed farming is general. Milch cows are also widely distributed, but are densest near the large cities, and in the black-soil region. The districts where they are subordinate to the beef cattle are the drier portions in the foot-

hills, the south of Alberta, and in south-west Saskatchewan. In general, it may be stated that most of the cream used for butter is produced on farms where dairying is a side-line rather than a major enterprise. Sometimes butter is an important article of export, at other times Canada has been an importer. Cheese, however, has been available for export for many years.

Sheep are relatively unimportant on the Prairies, for only about 8 per cent of the farms report them. As the map shows (Fig. 127) sheep are densest in southern Alberta, where there are many large sheep ranches. However, there is a large aggregate of sheep, based on the few kept by the small farmer, where they are found of much value as weed destroyers. In Saskatchewan shearing takes place in the early part of June. In winter sheep need protection from the continental climate, and they should have access to a dry shed giving shelter from cold winds. Moisture and draughts are more harmful than low temperatures. It is found that a pole shed, with a straw roof open to the south and closed on the other three sides, makes a cheap and efficient shelter.

Horses are almost uniformly distributed throughout the settled portions of the prairie provinces. But the coming of the tractor has resulted in a considerable diminution of horses on each farm. The drop began about 1916 in Manitoba and about 1921 in Saskatchewan. The peak was reached with 3·6 millions in 1921. There has not been much change in the totals in the three provinces in the last decade, as may be seen from the following table.

HORSES ON THE PRAIRIES

	Manitoba	Saskatchewan	Alberta
1931	324,659	997,000	731,000
1941	302,000	804,000	645,000

The distribution of *swine* follows closely the areas where coarse grains (oats and barley) predominate over wheat, i.e. in the more northern portions of the Prairies. The chief districts for hog raising are shown by the dotted patches in Fig. 127. The most important district is the area between Calgary and Edmonton, and there is also a close relation between dairying and hog-raising. The Yorkshire breed appears to be the best suited for the prairie farmer.

In concluding this description of agriculture on the Prairies, some data as to the average character of the farms will be found of interest. Mackintosh, in his book on *Prairie Settlement*, gives an interesting chart showing the variation in the size of the farms. This agrees in general with the amount of rainfall; so that in the

dry grazing districts of the south-west, farms are at times over 1,000 acres, though perhaps 500 acres is the normal size in southern Alberta and southern Saskatchewan. Along a line from Edmonton to Winnipeg, i.e. in the main *Wheat Belt*, the average size is about 350 acres; while in the northern Park Belt on the edge of the settlement with its *Mixed Farming* economy the size diminishes to 200 acres. Further data of interest reappear in the following table.

AVERAGE CONDITIONS IN THE THREE PRAIRIE PROVINCES, 1931

	Manitoba	Saskatchewan	Alberta
No. of farms	54,199	136,472	97,418
Rural population	54·9 % of whole	68·4 % of whole	62 % of whole
Size of farm	279 acres	408 acres	400 acres
Improved land	157·2 „	246 „	182 „
Wheat	48·3 „	110 „	81·5 „
Oats	28 „	31 „	25 „
Barley	21 „	10 „	7 „
Hay	5 „	—	—
Horses	6 head	7 head	8 head
Cattle	12 „	9 „	12 „
Sheep	4 „	2 „	11 „

Irrigation in Alberta

A very good account of irrigation will be found in the *Engineering Journal* (Montreal) for June 1937; where S. G. Porter describes in considerable detail the executed and projected schemes for irrigating the drier lands of the south of Alberta and Saskatchewan. Here is the 'short grass' country of the pastoralist, here soil and sunshine are satisfactory, but the rainfall is below 15 inches over large areas (Fig. 26). (See Recent Crops, p. 382.) Not much interest was taken in such schemes until the Canadian Pacific Railway had opened up this part of the province. In 1894 an act dealing with irrigation was passed; but some minor irrigation had been in operation long before this date (Fig. 128).

John Glen in 1879 irrigated 15 acres about 8 miles south of Calgary; but little more was done till 1893, when the Calgary Irrigation Company completed 6 miles of their main ditch. Unfortunately for the company a series of wet years followed, and little use was made of their works. About the same time another company led water from the Bow River, through a 30-inch pipe, to water about 2,500 acres close to Calgary.

In 1898 the Mormon settlers in the south near Cardston constructed a supply ditch, which brought water from the St. Mary River to farms near Magrath and Stirling. In 1900 this water was

conveyed as far as Lethbridge. This is now controlled by the Canadian Pacific Railway, and an area of 120,000 acres to the east and south of Lethbridge is receiving water.

The most extensive enterprise in Canada serves a large tract of railway land between Calgary and Medicine Hat (Fig. 128). As part of the terms of the construction of the railway, about 3 million acres was given to the railway in this region, and in 1903 the supply of water to it from the Bow River was undertaken. The water is directed into the irrigation flumes by a diversion weir near Calgary, which consists of a composite dam about 800 feet long. This is built partly of earth and partly of concrete and steel. The cost of the construction in the Western area (C.P.R.W. on the map) amounted to about 6 million dollars. Not many of the farmers use the water, and the total area irrigated is being reduced.

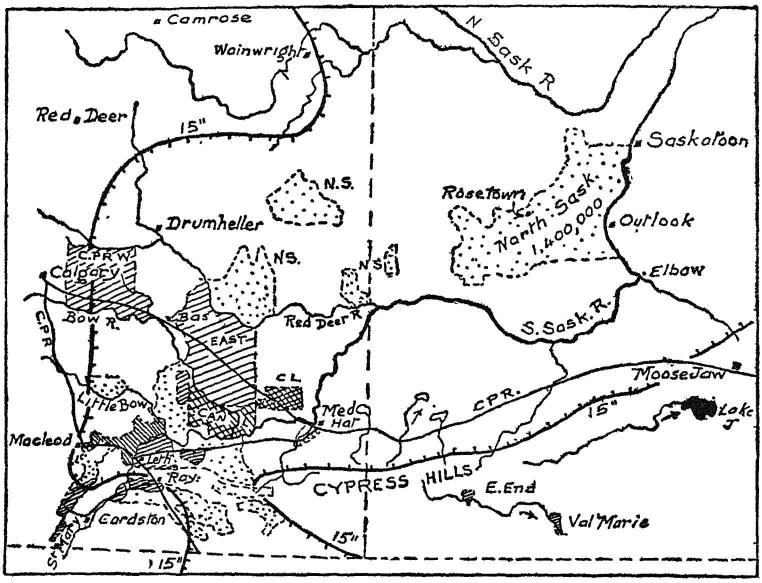


FIG. 128.—The Chief Irrigation Areas in Canada on the Bow and St. Mary Rivers. They are shown by diagonal ruling. *Suggested* irrigation areas are shown dotted. Most of the area affected receives between 13 and 15 inches of rainfall. (Based on a map by S. G. Porter)

The eastern section lies between the Bow River and the Red Deer River, where the average rainfall is about 12 inches. Construction of the dam at Bassano began in 1910 and the project as a whole was completed in 1914. The total length of the lateral flumes, &c., in this area amounts to 2,250 miles. The Bassano Dam is built of concrete, and is 45 feet high and 720 feet long. Brooks Aqueduct

is a concrete flume on a trestle 50 feet high, which carries the water across a valley 2 miles wide. Antelope Creek Siphon is another ingenious portion of the large project. The cost of construction and improvements by 1935 had amounted to 12 million dollars.

The Canada Land and Irrigation Company (C.L. in map) began irrigating large tracts of land between Lethbridge and Medicine Hat in 1919. Two dams cross the Bow River, and a canal 44 miles long leads the water to a supply reservoir at Lake McGregor. Over 100 main canals and some 1,400 lateral flumes are employed in this scheme, and about 40,000 acres out of the 210,000 originally planned are being irrigated. Smaller areas are irrigated near Taber just east of Lethbridge, and at a few other places indicated in Fig. 128.

Very little irrigation has been carried out in Saskatchewan, but at East End and Val Marie about 8,000 acres are irrigated. Two schemes are under consideration, one to take water from the big river near Elbow and serve a large area north of Moose Jaw. The other would divert water from the North Saskatchewan River near Rocky Mountain House, Alberta, and irrigate more than a million acres between Saskatoon and Rosetown. These projects would undoubtedly be extremely expensive, but the areas which may be affected are shown on the sketch map in Fig. 128.

ALBERTA—ALLOCATION OF WATER

(*thousand acres*, 1953)

St. Mary and Milk River	465	Private Projects	70
Eastern Irrigation	281	Western Irrigation	50
Bow River	240	United Irrigation	34
Lethbridge	96	Aetna Irrigation	7

Irrigated land in the vicinity of Calgary is still available in parcels of 80 to 160 acres, with half of it irrigable. For this the price in recent years has been about 35 dollars an acre for the irrigable portion, and 10 dollars an acre for the non-irrigable area. The water rental on irrigable land in this district amounts to 1·25 dollars per acre. A system of rotation under irrigation is found to be the best practice; with alfalfa and sugar-beets as a basis. Since plenty of water is available for watering stock, and an abundance of fodder crops can be grown, livestock raising is profitable on an irrigated farm.

The most characteristic crop grown in southern Alberta with irrigation is the sugar-beet. (In 1939 beets were grown on 60,000 acres in Canada.) The chief centre is at Raymond in the extreme south of the province, where there is a modern sugar factory with a

capacity of 1,000 tons of beets a day. In 1953 about 35,000 acres of beet were harvested near Raymond, producing 422,000 tons of beets. These had an average saccharine content of 18·19 per cent, and in 1953 the price paid for a ton of beets was 13 dollars. There is another factory at Picture Butte in Alberta. The total irrigated land for Alberta is about 370,000 acres.

Agriculture in British Columbia

The sections dealing with the topography and natural regions of this province will have made it clear that the lands suited for agriculture are quite scattered. Much the largest area is near the city of Vancouver in the delta of the Fraser River. Another isolated area is the south-eastern corner of Vancouver Island in the vicinity of Victoria. Then there are the parallel valleys near the southern border, such as Okanagan, Kettle River, Arrow Lake, and Kootenay. These become progressively drier to the west, so that they change from a fruit economy to one devoted to ranching. There is a region of ranching and some irrigation near Kamloops. A promising area is being developed near Prince George, and the early days of a pioneer region can be observed along the railway to Prince Rupert in the vicinity of Hazelton.

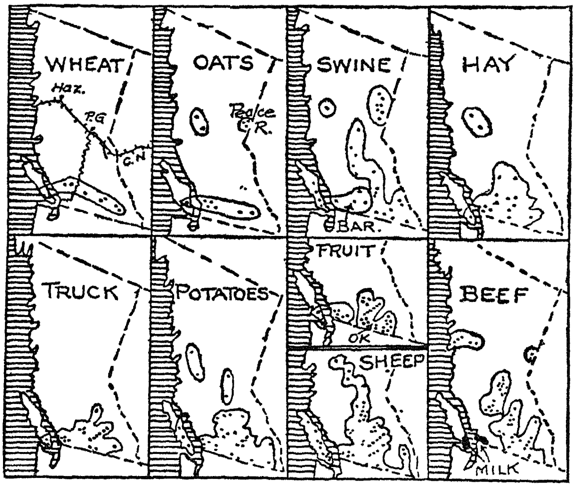


FIG. 129.—Distribution of crops and stock in British Columbia. Barley (Bar.) is charted in the third map. (After McArthur and Coke)

In Fig. 129 the distribution of the chief crops is given. It is based on *Farmer's Bulletin No. 77*, by MacArthur and Coke, entitled

Types of Farming in Canada (Ottawa 1939), which should be in the hands of every geographer. The relative acreage of the various crops of British Columbia is given in one of the columns in the preceding table on p. 382. Hay is the chief crop ; followed by wheat, oats, and alfalfa, which occupy much the same acreage. Potatoes and barley are of much smaller importance. In 1931 the population was more urban than rural, the proportion being 57 to 43 per cent. There were 26,079 farms, with an average of 136 acres per farm. About 14,000 of these farms contained orchards, but the chief fruit production is concentrated near Okanagan, as is clear from one of the maps in Fig. 129. (See Recent Crops, p. 382.)

The pamphlet referred to states that there are no less than 39 isolated farm areas charted in the broken topography which makes up British Columbia. Even on Queen Charlotte Island far out in the Pacific there is a certain amount of dairying, while potatoes and poultry are grown. On *Vancouver Island* there are over 46,000 acres under cultivation; the chief acreage being given to hay and clover (some 20,000 acres), followed by oats (10,000 acres), with some wheat and potatoes. Fruit growing, especially of strawberries, is carried on in the Keating district, and much fruit is shipped to the Prairies. Dairying is successful, and co-operative creameries are operating near Courtenay, Cowichan, and Nanaimo. A rather large proportion of the sheep of the province are found on Vancouver Island, as is evident from the small map in Fig. 129.

In the *Lower Fraser valley* near Vancouver there are many truck gardens, where vegetables, &c., find a convenient market in the large population of Vancouver (275,000). Dairying, potatoes, poultry, and small fruits are also characteristic of this corner of the province. There is only a small production of cereals, but the cultivation of wheat is confined to the belt along the U.S.A. boundary, especially near Kootenay, and a fair amount of the oats is grown in the delta. Much the same crops are grown at Howe Sound, around Squamish, some 20 miles to the north of Vancouver.

Okanagan, Similkameen, and Kettle River are linked by their common interest in fruit-growing. Here the long terraces, which have been described in an earlier section (p. 184), lend themselves to a simple form of irrigation. The tributaries of the main rivers are dammed, and flumes lead the water down to the terraces along the main valleys. In this way have developed the famous peach orchards of the Okanagan valley, as at Penticton, Peachland, Kelowna, &c. Many car-loads of apples are also exported to Great Britain, from the shores of Lake Okanagan,[1] and perhaps 80 per cent of the fruit grown in the province comes from this long narrow valley.

[1] A full discussion of the apple industry in Canada by Davis and Wheeler will be found in the *Canadian Geographical Journal* for September 1938.

The south-east corner of the province around Windermere, *Cranbrook*, and Fernie is largely devoted to rearing cattle, with hogs and poultry as other products. The dry character of the central portion of British Columbia also lends itself to the rearing of sheep and cattle, and this type of industry extends north to Quesnel, where the rainfall improves. Thus the chief beef-cattle regions are *East Kootenay*, *Kamloops*, and the *Cariboo* country near the middle Fraser River. The total area of lands which are fairly satisfactory for raising cattle is set at 160 million acres, and it is believed that they can carry up to six times as many cattle as at present range thereon. Sheep have attracted less attention than beef cattle, and cover much the same region, being most numerous in the dry flat expanses of the Interior Uplands (p. 197).

All along the northern railway from Yellowhead Pass to Prince Rupert is a string of pioneer settlements, of which some description appears earlier in the book (p. 199). Here mixed farming is the rule, with oats and potatoes as the chief crops. Alsike clover for seed is important. Dairying is making progress, especially near *Prince George*, and there is a considerable development of poultry farming. Distance from markets is of course the chief difficulty in this section of the province.

In the far north-east of British Columbia is the *Peace River Block*, set apart in the early days of railway building as compensation to the construction company for the lack of suitable farming lands along the Canadian Pacific Railway route farther south (Fig. 81). Here in this distant corner of the province, which has no ready connexion with the rest of British Columbia, is a veritable sample of prairie land, sadly lacking in the rest of British Columbia. Wheat, feed-grains, and hogs are perhaps the leading staples (Fig. 129). The 'Block' is shown by faint lines surrounding St. John in Fig. 81.

About 17 per cent of the arable land in British Columbia is under cultivation, and nearly all the grazing area is being utilized. The 1,100,000 acres developed in 1952 give a ratio of approximately one acre per person. Within this arable area there exist an estimated 163,777 acres of irrigated land, and the total acreage of irrigable land in British Columbia is estimated at 181,974 acres.

The chief irrigated areas are at Summerland (3,407 acres), Southern Okanagan (4,200 acres), Black Mountain (4,174 acres), South-east Kelowna (2,777 acres). Nearly all these are near Lake Okanagan. (*Yearbook.*)

CHAPTER XVII

THE MINING INDUSTRY

PART I: MINERALS IN GENERAL

The Relation of the Minerals to the Build of Canada

IN Chapter III the main features of the build have been described, and these have been elaborated in the sections dealing with the Natural Regions. In this present chapter special attention is paid to the distribution of the minerals, which are of course closely related to the geology and structure. A good summary appears in the valuable manual by Malcolm and Robinson,[1] where the best short account of the chief mines of the Dominion may be found.

In the Appalachian and Acadian regions are the *asbestos* products of south-eastern Quebec, which for a long period have furnished the world with the greater part of its supply of this commodity, and the important *coalfields* of Nova Scotia. Within the St. Lawrence region are the *salt* beds and *petroleum* fields of southern Ontario. The Canadian Shield contains the Sudbury *nickel-copper* mines, which are the world's chief source of nickel, the spectacular *goldmines* of Porcupine and Kirkland Lake and the rich *silver* deposits of the Cobalt district. The Interior Plains over hundreds of square miles are underlain by *coal*. In the Cordilleran region are extensive *coalfields*, important *placer* goldfields, large deposits of *copper-gold* ores and of silver-lead-zinc ores. In the Arctic Archipelago scattered deposits of coal are known to exist.

In a companion volume on Australia in this series, I point out that four of the great natural resources are linked with four rather different periods in the geological record. The *metallic* ores in Australia are never found associated with rocks later than the Paleozoic, and most of them derive from rocks earlier than the Carboniferous. The great *coalfields* naturally date from Carboniferous or later ages, since there were no coal-producing plants of importance before this time. The great water-bearing *artesian* beds in Australia are mostly of Mesozoic age or later; while the deposits of thick *soils* usually occur in the latest synclines associated with late Tertiary or Quaternary deposits. Thus it was possible to mark four areas on the geological map where metals, coal, artesian water, and soils were respectively dominant.

Such a simple generalization is not possible in Canada, and indeed artesian water is of negligible importance in this continent.

[1] *Canada, Geology, Mines, &c.*, Dept. of Mines, Ottawa, 1927.

But the picture is complicated in regard to the metallic ores, for many of the most valuable ore deposits are associated with Jurassic or even Tertiary rocks in Canada; and so belong to the last 50 or 60 million years, instead of going back some 200 million years as in Australia. However, some major principles are obvious in Canada regarding ore deposition, which may well be discussed briefly.

Metallic ores usually derive from the deeper portions of the earth's crust, and have reached the surface of the earth by transfer in hot vapours or liquids for the most part. There are thus three predisposing factors in ore deposition (as well as many others which cannot here be considered). These are the *age* of the rocks, the prevalence of *cracks* (faults) and crustal movements, and the presence of marked *igneous* activity at some stage in the history of the rocks involved. If we examine the geological map we find that nearly half the Dominion consists of the Pre-Cambrian Shield, which satisfies the condition of age, thus affording long periods in which faulting, folding, and igneous activity may have taken place. (The younger the rocks, the less chance there is of such activities.) Other large areas, though younger, show that much igneous activity has occurred, and such are rather favourable sites for metals. Yet others have been involved in mountain-building processes, and these are often accompanied by igneous activities, and often linked with faulting and folding. Level plains of fairly young deposits have been affected by none of the favourable factors, so that we can ignore them in our search for metallic mining fields.

On the other hand, it is precisely these relatively young sediments, which have not been folded or faulted, which are likely to contain large beds of coal. This is illustrated in several parts of the Dominion, especially in the shallow 'basins'. Finally, the largest region of good agricultural land is clearly determined by the presence of the main geosyncline between the Shield and the Young Mountains of the west. Into this wide and shallow fold in the crust have poured gravels, silts, and sands and other forms of soil torn from the mountains to the west. Here have collected the major rivers, such as the Saskatchewan, Peace, and Mackenzie, and here are the best agricultural lands as was fully demonstrated in the sections on prairie agriculture.

These various features of the structure of Canada are charted in a simplified fashion in Fig. 130. Here the dominant formation is the Shield, which is shown underlying three geological basins; that of the Maritimes in the far east, and the Michigan basin in the east, while the great Cretaceous basin of the Prairies appears in the west. At the far west the major folds of the Rocky Mountains are indicated. Almost all the mining areas mentioned in the former paragraph are charted here. The Sydney coalfield is seen to be a

small outlier of the Maritimes, while the Moncton-Pictou coal belongs to the main basin. The Thetford asbestos mines are on the margins of Appalachian anticline (upfold). The great goldfields of Porcupine and the nickel of Sudbury are in the ancient rocks of the Shield. The gas and salt are found on the rim of the Michigan Paleozoic Basin in Ontario. Steep Rock, one of our promising iron deposits, is in the exposed Shield east of Winnipeg, while Flinflon (lead-zinc) is to the north of this city.

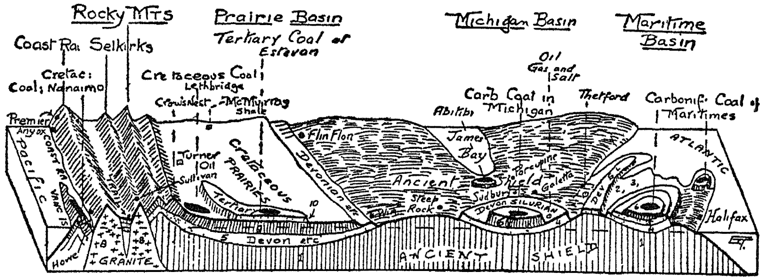


FIG. 130.—A much simplified diagram to explain the distribution of the coal and metal mines in Canada. A section through the crust appears at the front edge. The numbers indicate the relative ages of the deposits. Coal is shown black

No metal mines can be expected in the vast Cretaceous Basin, but the Tertiary coals of Estevan and the Cretaceous coals of Lethbridge and Crow's Nest are indicated. The Turner Valley oil field is here also. Far to the north are the shales which contain the tar deposits near McMurray, also in young formations. In the Rockies proper there are not many ore deposits, but the Selkirks and the Coast Ranges, buttressed by giant masses of granite and other igneous rocks, are rich in metallic ores. The great Sullivan mine at Kimberley is charted, as well as Trail near the Rossland and Nelson mines. Along the coast are the gold- and copper-mines of Premier, Anyox, and Howe Sound, which are shown in the diagram.

It would be impossible to describe the thousand and one mines of the Dominion, but the outstanding features of the mining industry, the relative importance of the metals and coal deposits, and some illustrations of the chief ore-deposits will be discussed. Indeed, the writer is of the opinion that many so-called mineral maps which chart almost every discovery, with little emphasis on size and importance, are of small value. The student will do better to concentrate on the general principles and on the great mines of Dominion or world interest, and to ignore the small mines of ephemeral and local importance only.

The Development of Mining

Some account of the development of mining has appeared in Chapter XIII. The first reference to the coal of Nova Scotia was published by Monsieur Denys as early as 1672. Bellin's maps, published in 1744, indicated the existence of silver-lead close to the Cobalt mines of today. The sole mining of importance in the days of the French regime was connected with bog iron ore, in the vicinity of Three Rivers. In the 'sixties of the last century the Geological Survey was established, and Logan published his *Geology of Canada* in 1863. Some of the earlier fields to be exploited were the Thetford mines in the Quebec, the Cariboo goldfields, the gold ores of Nova Scotia, the copper-nickel of Sudbury, the silver of Silver Islet off Fort William, the copper-gold of Rossland and the silver-lead of the Kootenays.

Thus the real riches of the Shield were not discovered until the beginning of the present century, about the time that the Yukon gold rush was at its peak. Although Sudbury was discovered in 1883 and the Kimberley mine (B.C.) in 1892, not much in the way of development was done in the last century in either case. Cobalt started about 1903 and reached its zenith in 1911. By 1925 there were 20 mines in operation in the district, but most of these have since closed. The Sudbury field became of much importance after the Mond interests acquired several mines about 1900. The Levack Mine was opened up about 1913, and the nickel refinery at Port Colborne was erected in 1918. The rush to the Porcupine field near Timmins started in 1909, while Kirkland Lake followed in 1913, and the chief mines at Rouyn (in Quebec nearby) were not exploited till 1922.

In the Prairies natural gas was tapped near Medicine Hat as early as 1908, and the Turner valley oil field was proved in 1913. Flinflon on the north-east borders of the prairie was opened up in 1916; while the Long Lac mines north of Lake Superior were not discovered till about 1926. In British Columbia the main gold-producing fields are Bridge River, Portland Canal, Cariboo, Kootenay, Hedley, and Zeballos. Placer mining is now of little significance, and the gold comes from veins or vein-like replacements. Copper comes chiefly from Britannia and Copper Mountain. One of the most interesting developments is the mercury deposit which was discovered at Pinchi Lake (north of Prince George) in 1938. Only in the Yukon is placer gold of importance, where it is being recovered by giant dredges, which in recent years have been re-working the tailings and debris of the former diggings.

From the table it is obvious that in recent war years the value of the gold production has increased enormously, about three times

STATISTICS OF THE MINING INDUSTRY, 1932 AND 1953

(*millions of dollars*)

	1953	1932		1953	1932
1. Gold	140	63	7. Platinum, &c.	12	2
2. Nickel	161	7	8. Lead	52	5
3. Coal	102	37	9. Petroleum	198	3
4. Copper	151	15	10. Natural Gas	11	9
5. Asbestos	88	3	11. Silver	25	6
6. Zinc	95	4	12. Iron Ore	45	—

in the last decade. Gold has dropped in value to about the same as the next metal, nickel, and in both products Canada stands high. She is the world's chief producer of nickel, and the second largest producer of gold. Nickel has also been produced on a much greater scale in the war years, the value having increased nine times in the decade. Part of this increase is of course due to enhanced prices, but part is due to actual increase in production, especially in metals of great military importance such as nickel.

In the following table the minerals are listed according to their importance in the various provinces of the Dominion.

MINERAL PRODUCTION IN THE PROVINCES IN 1953

(*values in dollars*)

Mineral	Nova Sc.	N. Br.	Quebec	Ont.	Man.	Sask.	Alta.	Br. Col.
Petroleum ($)	—	20,000	—	995,000	2 mil.	4 mil.	194 mil.	—
Nickel ($)	—	—	—	160 mil.	—	—	—	—
Copper ($)	472,000	—	32 mil.	78 mil.	6 mil.	18 mil.	—	14 mil.
Gold ($)	111,000	—	35 mil.	75 mil.	4 mil.	3 mil.	—	9 mil.
Coal ($)	52 mil.	6 mil.	—	—	—	4 mil.	32 mil.	9 mil.
Asbestos ($)	—	—	81 mil	4 mil.	—	—	—	—
Zinc ($)	2 mil.	—	24 mil.	—	4 mil.	12 mil.	—	46 mil.
Lead ($)	—	—	2 mil.	—	—	—	—	38 mil.
Silver ($)	—	—	4 mil.	4 mil.	—	1 mil.	—	8 mil.
Total, with others ($)	67 mil.	12 mil.	252 mil.	466 mil.	25 mil.	48 mil.	248 mil.	158 mil.

Newfoundland: Fluorspar 3 mil.; Lead 5 mil.; Zinc 7 mil.; Copper 2 mil.; Iron ore, 14 mil.

Since the chief values of some of the *outlying* territories of the Dominion are found in the minerals, these are listed in the following table.

MINERALS IN THE TERRITORIES, 1953

Yukon		North-West Territories	
1. Gold	$2 million	1. Gold	$10 million
2. Silver	6 "	2. Silver	53,000
3. Lead	4 "	3. Petroleum	257,000
4. Tungsten	2 "		

There are many other mineral products of less intrinsic value which are produced in notable quantities in one or other of the provinces, and some of these are given in the following table:

LESS IMPORTANT MINERALS, 1953

Ontario		Quebec	
Mineral	Value (dollars)	Mineral	Value (dollars)
1. Cement	$18 million	1. Cement	$19 million
2. Lime	8 "	2. Lime	4 "
3. Salt	4 "	3. Clay	8 "
4. Clay	15 "	4. Mica	99,000
5. Quartz	1·3 "	5. Peat	587,000
6. Nepheline Syenite*	1·5 "	6. Feldspar	319,000
7. Fluorspar	38,000		
8. Iron Ore	23 million		

* Feldspar from Frontenac and Lakefield, used for pottery, &c.

From this last table it is obvious that Ontario not only is in the lead as regards the more valuable minerals, but also ranks first with regard to those just tabulated. Of the remaining provinces only two are of importance in this connection. They are Nova Scotia and Saskatchewan. The former produces gypsum worth 5 million dollars, and barytes to the value of 2½ million dollars; while Saskatchewan supplies sodium sulphate worth over a million dollars. Clay, lime, and cement are of course produced in every province to a considerable extent. The Quebec–Labrador iron mines may contain 300 million tons of iron. It was expected that 40,000 tons of ore would be loaded *daily* at Sept Iles by 1954.

PART II

COAL, OIL, ASBESTOS, AND IRON

The Origin of Coal and Coalfields

Some general notes on the origin of this mineral will enable us to understand the variation of the coals, which are found rather widely distributed in space and in geological time in the Dominion. Coal is of course derived from plants which have been grown under suitable circumstances, and have subsequently been subjected to pressure and chemical changes. All stages of coal production are illustrated in the samples found in Canada, such as the swamps of the muskeg with their abundant sphagnum moss, which may in a few million years produce the coals of the distant future, to the bright dense anthracite, which represents the end-process of chemical change, and which occurs in some of the mines in the Rockies.

In most of the largest coalfields of the globe the coal seems to have been derived from swamp-ferns and allied plants which grew in Carboniferous times. This date goes back 200 or more million years, and is not long after the first mantle of vegetation spread over the continents. Indeed, there are hardly any places in the world where coal of Devonian age occurs, since so few suitable plants grew then. However, it is of interest to note that *Psilophyton* (from Gaspé in Quebec) is said to be one of the earliest of land plants, and it goes back to Silurian times.

In the far-distant Carboniferous times we seem to discern vast swamps filled with shallow-water ferns and early trees; and these shallow swamps must have been *slowly subsiding*. Hence the new plants were able to grow upon the debris formed of their predecessors. Only in some such fashion can we explain the very great thicknesses of solid coal, without any alternating layers of shale or grit. The latter would inevitably result if the process of gradual subsidence were interrupted long enough for deep water to halt the growth of the peat plants, permitting layers of plantless silt to cover the earlier plant remains.

It is also worthy of note that coals must have developed in humid climates for the most part, for if the coalfields of the world are charted they are found to lie almost wholly in the humid areas of the world today. The large areas of lignite in the Rockies of U.S.A. are, however, an exception. Since coals occur in every geological age since Devonian times, their distribution would seem to be some slight indication that the humid portions of the earth have not radically altered in the last 250 million years. (This deduction seems to the writer to invalidate the Wegener hypothesis of drifting continents to some extent.)

The pressure of subsequent deposits of sand, &c., consolidates the peaty material, which slowly loses much water and gas. But the ash, representing the lime, silica, &c., in the plants, as well as accidental inclusions of soil, is not altered by the pressure. However, the proportion of carbon steadily increases with the age of the coal deposit. It is stated that peat can be artifically converted into hard brilliant coal merely by subjecting it to a pressure of 6,000 atmospheres.[1]

The somewhat generalized table which follows gives approximate percentages (in the various types of coal) of water, ash, gas, and fixed carbon. The latter component is much the same as the *coke* portion of the coal remaining after the gas has been removed. It seems likely that bacteria help to change peat into a brown pasty mass, which binds the plants into a compact material, ultimately becoming lignite. In many parts of the world, such as near Crow's Nest (Alberta), it has been noticed that the same seam may appear as bituminous coal or anthracite according to the amount of earth-folding which has affected the coal. *Caking* (or coking) coals are low in oxygen, and contain 25 to 30 per cent of gas. They soften when heated, so that the fragments coalesce and yield a compact coke. This makes them specially suitable for use in blast-furnaces, for air can penetrate the coke better.

COMPOSITION OF TYPICAL COALS

	Dried peat	Lignite	Bituminous	Anthracite
Specific gravity	Variable	1	1·3	1·5
Fixed carbon	24%	36%	55%	95%
Gas	60	41	32	2
Ash	10	9	10	2
Moisture	up to 90%*	14	2	1

* Before drying.

The probable coal resources of the world are given in the recent report of the Commission on the Coal Industry (Sydney, Australia, 1930) as follows:

WORLD'S COAL

(*in thousand million tons*)

North America	5,073	(including U.S.A. 3,838 and Canada 1,234)
Asia	1,279	(,, Siberia 174, China 995)
Europe	784	
Australasia	170	
Africa	57	(almost wholly in South Africa)
South America	32	(almost wholly in Colombia)

[1] These notes are summarized from the discussion on coal in the companion volume on Australia.

It is to be noted that these estimates vary a good deal from decade to decade. Thus some estimates of Siberia's coal place it as high as 1,260 thousand million tons; while recent estimates of probable workable coal in Alberta give the figure of 46 thousand million tons, which is much lower than most former estimates.

The Coalfields of Canada

Elwood Moore, in his valuable book, *Canada's Mineral Resources*, discusses the relative merits of coal, petroleum, and hydro-electric energy; and a few of his conclusions may be quoted. A pound of bituminous coal yields about 12,000 British Thermal Units, while the same weight of oil gives about 20,000 such units. Generally speaking, more of the energy can be utilized from the oil than from the coal. But at the time of his writing the production of coal was far greater than that of oil, the ratio being about 9 to 1 in favour of the coal. Moreover, the total supply of the coal is much greater than that of the oil. One pound of coal burned in an internal combustion engine will furnish one horse-power of mechanical energy. Moore states that the hydro-electric power of the Dominion is equivalent to about 135,600 short tons of coal a day. The 5 million horse-power developed by hydro around 1928 therefore represents a saving of 30,000 tons of coal per day.

The geological ages of the Dominion coalfields are given in the table on page 422, and it will be seen that they range through the whole of the period since Lower Carboniferous times. (The older beds are at bottom of the table.)

The Sydney Coalfield on Cape Breton Island (Nova Scotia)

There are four coalfields in Nova Scotia, all belonging to the Upper Carboniferous Age. The deposits at Joggins, Pictou, and Inverness, are of much less importance than those at the far eastern extremity of the Dominion in the north-east of Nova Scotia near Sydney. In this part of the province the build consists of a series of corrugations of the crust, which form alternating synclines and anticlines with the axes running north-east to south-west. These corrugations are shown somewhat diagrammatically in Fig. 131. As usual, the young upper layers are preserved in the synclines, while the tops of the ridges have been worn away, and often here the ancient lower rocks are exposed. All the formations dip gradually to the north-east, and so the youngest beds are found actually on the sea coast. It is in this upper layer that the coal seams occur.

This Sydney Carboniferous basin contains a tremendous thickness of strata, estimated to be over 12,000 feet deep, but it is the upper beds alone which contain the coal. There are six separate small fields near Sydney, in which the total thickness of workable

GEOLOGICAL AGE OF COALFIELDS

Age	Province and district	Character of coal, &c.
Quaternary :		
Recent	Most provinces	Peat
Pleistocene	Ontario, James Bay	Lignite (very poor)
Tertiary :		
Miocene, &c.	Br. Columbia	Lignite and allied coal
Eocene	Estevan (Sask.)	Lignite to Bituminous
Mesozoic :		
Upper Cretaceous	Saskatchewan and Alberta and Br. Columbia	Lignite to Bituminous
Lower Cretaceous	Kootenay Series in Western prairies and B.C.	Bituminous to Semi-anthracite
Paleozoic :		
Pennsylvanian	Nova Scotia and New Brunswick (and Arctic)	Bituminous
Mississippian	Some Arctic islands	

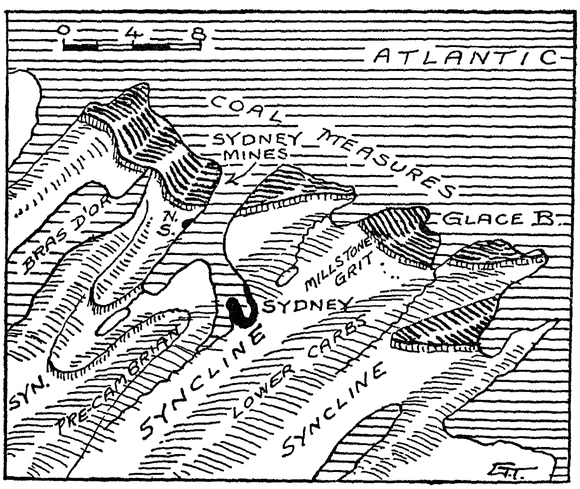


FIG. 131.—A mantle-map of the coal measures near Sydney (N.S.). They occupy the upper beds in the synclines of corrugated Paleozoic formations

coal varies from 23 feet up to 47 feet. The coal is bituminous, and the output has been 5 or 6 million tons a year for a long period.

The coastline is broken by bays and channels running inland parallel to the axes already mentioned. The chief of these is the harbour of the large industrial town of Sydney, which has grown up on the south arm of the largest indentation. Another smaller gulf about 12 miles to the north-east is Glace Bay, where the largest coal-mines are situated. At Cow Bay, and near Victoria, are two other coal districts; while further to the north-west are Sydney Mines and New Campbellton.[1] In all of these fields the beds of coal have the same structure (Fig. 131). Owing to the dip of the seams they pass under the ocean, and many of the workings are 2 miles to the east of the coast in consequence. At the outer portion of the workings the sea is 60 feet deep and has broken into a few of the tunnels, so that some mines have been abandoned (Moore, *loc. cit.*).

The coal at Sydney has a low ash content, with sulphur 3 per cent and fixed carbon 56 per cent. It can be turned into good coke, suitable for use in the huge blast furnaces at the steelworks of Sydney. As mentioned elsewhere the iron ore is brought to this town from Wabana in Newfoundland.

The *Inverness* mines are in the south-west corner of Cape Breton Isle, and here also the mines have been driven for a considerable distance under the sea. The seams mined are about 6 feet thick, but the coal is rather high in sulphur and is not suitable for coking. Near *Pictou* is the third main coalfield of Nova Scotia, with a number of small towns such as New Glasgow and Stellarton which depend on the mines (Fig. 44). The coal is somewhat faulted, and the Stellarton field contains some seams of cannel-coal and oil shale. The coal from this field has a low sulphur content, but the ash is higher than at Sydney; however, some of the coal is suitable for coke production.

The fourth of these small fields is just south of Amherst, at Joggins and *Springhill*. The former is noted for its remarkable fossil trees, which were described by Sir Charles Lyell as long ago as 1842. Most of the seams are thin, but the best at Springhill has a thickness of 13 feet. Here the coal dips steeply to the west, in some cases as much as 50 degrees. The Springhill coal is of fine quality with low ash and sulphur, but that from Joggins has much lower values and cannot be used for coke.

The Alberta Coalfield

According to the estimates of Dowling and others before 1911

[1] Several useful maps of the Sydney coalfield will be found in the *Guide Book*, No. 1, Part II, of the Transcontinental Excursions, published by the Geological Survey, Ottawa, 1913.

the Alberta coalfield of Cretaceous age contains almost the largest supply of coal in the world. Former estimates were in the neighbourhood of 1,000,000 million tons, and this amount is only second to the estimated supply in the Northern Rocky Mountain and Northern Plain areas of U.S.A., which was set down by the same International Geological Congress of 1911 as about twice the amount in Alberta. But later estimates have much reduced the figures for Alberta, and the latest estimate is only 46,500 million tons. However, this will give us a supply equal to the current output of Germany for several centuries; and this consideration is of much importance when we try to forecast the future industrial expansion of the Dominion (p. 511).

The dominant structure of Alberta is a broad geosyncline (with a north–south axis) occupying most of the province. The floor of this great trough consists of Devonian rocks in the east, and of Jurassic rocks along the uptilted edges along the Rocky Mountains. The general sequence of these formations is given in the following table from Malcolm and Robinsons' brochure (*op. cit.*).

FORMATIONS IN THE ALBERTA GEOSYNCLINE

Age	Formation	Type	Thickness (feet)	Remarks
Early Tertiary	Paskapoo	Sandstones and shales	4,000	Coalspur mines 150 miles west of Edmonton
Cretaceous Montana	Edmonton	Green sediments with *coal* at base	1,300	Mines at Drumheller, Edmonton, Tofield
	Bearpaw	Marine shales	?	
	Belly River	Sandstones with *coal* at top	1,800	Mines at Lethbridge, Taber, and Coalspur (Jasper)
Colorado	Benton	Black shales	2,400	Easily eroded to form valleys
	Blairmore	Thin freshwater shales, &c.	950	Form ridges
	Kootenay	*Coal* with hard sandstones	400	Mines at Fernie, Blairmore, and Calgary
Jurassic	Fernie	Marine shales	500	
	Rundle	Limestones	?	

As the table shows, there are four important coal-bearing horizons in Alberta, and as one might expect the older Western coals are of somewhat better quality than the younger eastern types. But where the coal has been squeezed and altered in the process of building the Rocky Mountains we find that the coal is compacted

and altered in the direction of an anthracite coal as at Banff. This change is clearly shown in some of the seams in the Belly River field; for in the east, where the rocks are not affected by the folding forces, the moisture content may be as much as 26 per cent (as at Redcliff), while as we move to the west the figures change to 15 per cent at Taber, 10 per cent at Lethbridge, and 7 per cent at Pincher near the mountain divide. The heat values change correspondingly, from 8,320 B.T.U. per lb. at Redcliff to 11,190 B.T.U. at Pincher.

PROXIMATE ANALYSES OF SOME WESTERN COALS

Mine	Moisture	Ash	Volatile matter	Fixed carbon
C.P.R. at Bankhead (Banff)	0·5	9·7	8·2	81·6
Canmore No. 2 (Banff)	0·9	5·4	14·0	79·7
Crow's Nest, Michel (Fernie)	1·2	10·1	23·8	64·9
Galt No. 6, Lethbridge	8·9	9·7	33·7	47·7
Midland, Drumheller	12·5	8·2	31·6	47·7
Shand, Saskatchewan Coal Co. (Estevan)	26·9	9·6	27·8	35·7

Many seams of considerable thickness are found in each of the three coal-bearing formations (Fig. 132). Thus at Blairmore near Crow's Nest Pass six seams are encountered in 277 feet of the coal measures. These vary in thickness as follows: 10 feet, 17 feet, 3½ feet, 3½ feet, 17 feet, and 6 feet. At the Fernie field, just over the border in British Columbia, 23 seams totalling 172 feet of coal are found in 2,250 feet of coal measures. Farther north at Sheep Creek (south-west of Calgary) a tunnel was driven 2,250 feet across the steeply-dipping Kootenay measures, and cut seven workable seams. In east-central Alberta the complete section of the Edmonton formation is 1,224 feet thick, with fourteen coal seams having an aggregate thickness of approximately 62 feet. The lignite coals at Drumheller, Lethbridge, and Edmonton are used locally; while the better coals of the Crow's Nest field serve the railways here and in nearby U.S.A. The boats on the small lakes, and the numerous smelters are also furnished with coal or coke from this coalfield.

Minor Coalfields in Canada

In *Manitoba* there are few deposits of importance, the chief being found in Turtle Mountain on the International boundary. Its position is indicated in Fig. 132. The coal is a lignite of Tertiary age, and there are said to be about 175 million tons available.

In *Saskatchewan* the only coal that is mined to any great extent is of the same Tertiary age. It is found in several seams near

Estevan (Fig. 132); and some of it is of better quality than that in Manitoba approaching bituminous. Unfortunately, it does not stand weathering well, but it is a useful local fuel (Moore, *Mineral Resources*). There is also an extension of the Alberta Cretaceous coal in the south-west corner of the province, and several seams have

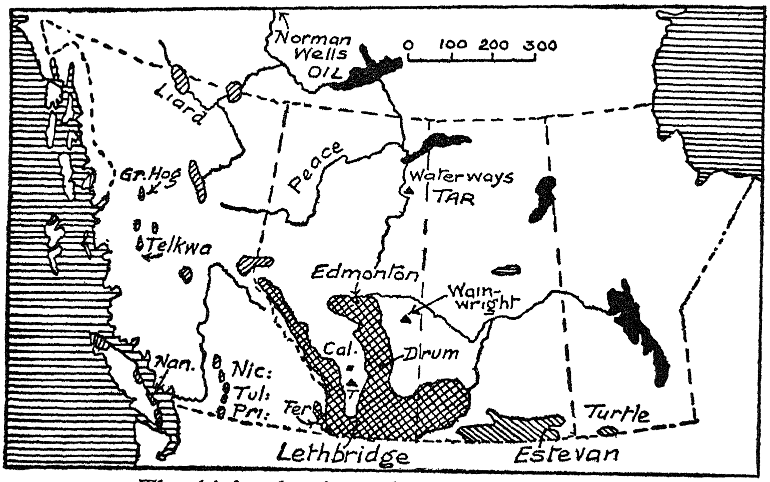


FIG. 132.—The chief coal and petroleum fields in western Canada. The huge Alberta field is cross-hatched. Oil is shown by black triangles. (T. is Turner Valley). Leduc oilfield is 20 miles south of Edmonton

been proved in bores at Maple Creek. Probably a great deal of this coal is buried deep under younger deposits, where it has not yet been found profitable to exploit it. The analysis of the coal at the Shand Mine near Estevan appears in the table.

There are many coalfields scattered throughout *British Columbia* which are of various ages akin to those already described for Alberta. Their general characters are given in the following table:

BRITISH COLUMBIA COALFIELDS

Age	Locality	Character
Tertiary	Princeton	Range from lignite to bituminous
	Tulameen	Bituminous, partly under lava
	Nicola	Low-carbon bituminous coal
Upper Cretaceous	Nanaimo	Chief field in the province
Lower Cretaceous	Bulkley River	
	Groundhog (Skeena R.)	Anthracite
	Fernie	

Of these mines much the most important are those already described at Fernie (Crow's Nest) and at Nanaimo on Vancouver Island. Coal from the latter is naturally used a good deal on the Pacific steamers, but it has a strong rival in the oil fuel from the Californian fields.

In British Columbia the coal is only second in amount to that found in Alberta. The field around Fernie is of the same age as that worked near Blairmore and Crow's Nest, but here the seams are more disturbed by mountain-building processes. In the Elk River field there are some very thick seams, one being as much as 31 feet. The seams at Tulameen and Nicola and other sites near Princeton (Fig. 132) are of Oligocene age; but in spite of its youth the coal is of bituminous quality and is said to make good coke. Seventeen seams have been found near Princeton, the largest being 18 feet thick. Near Kamloops are other seams of Miocene age, but they have not been much developed.

In the centre of the province along the Skeena River are small fields especially near Telkwa. Some seem to be Tertiary and others Cretaceous (Fig. 132). The Groundhog field at the head of the Stikine River has coal approaching anthracite of Lower Cretaceous age. On Vancouver Island the chief mines are at Nanaimo, but others are worked at Comax and Suquash on the east coast of the island. The coal is bituminous and produces a fair coke. At Nanaimo the workings extend a considerable distance under the sea.

Petroleum and Natural Gas in the Dominion

Natural gas was discovered in Ontario in 1888 near Leamington, and a little later near Welland, both on the shores of Lake Erie. From these fields supplies of gas were exported to Buffalo, Toledo, and Detroit. The Essex field tapped gas in the Middle Silurian limestone and ceased to produce in 1904, but the Welland field continued to supply gas up to modern times. Other fields have been developed along the north shore of the lake, and in 1934 there were 1,766 producing wells. Some of the later discoveries collect gas from the deeper Silurian and Ordovician limestones. The chief wells are near Tilbury (west of Chatham) in the narrow isthmus between Lake St. Clair and Lake Erie. The gas in this field comes from the Guelph formation of Middle Silurian age, and has supplied a population of 200,000 for 25 years.[1] The peak year was 1917, but it is still used largely for heating houses, cooking, &c. Other sources of gas have been found near Hepworth in Bruce Peninsula (Ontario). Ontario produces gas equal in value, though not in quantity, to that

[1] The position of these gas and oil strata is suggested in the Devonian-Silurian beds in Fig. 130. Gas and oil were found at Oil Springs in 1857.

obtained in Alberta, the totals in recent years being about 6 million dollars in each province.

Some natural gas is found near Moncton in New Brunswick, where the annual product is worth about 300,000 dollars. Alberta, however, has the largest supplies, nearly three times as much as Ontario, and this comes from a number of fields, such as Turner Valley, Medicine Hat, Wainwright, and Lloydminster (Fig. 132).

Petroleum is one of the most important of natural resources as a basis of heat, power, and chemical derivatives. There are a number of conditions which usually must be satisfied before an environment can be considered favourable for oil prospecting. Since the oil is a hydrocarbon, due to chemical alteration of organic matter, it is obvious that rocks which contain no organic matter are not likely to yield oil. This fact cuts out such rocks as build up the great Canadian Shield, which are in general devoid of all relics of organic life. Most authorities agree that large accumulations of bygone *animal* life are quite favourable, and these are usually found in marine shales, &c. Hence such environments if indicated on the geological map are favourable.

The most valuable indication for oil is, however, the presence of 'domes' in the strata, i.e. upfolds where oil globules may find room to collect as they seep upwards. Such gentle domes or anticlines are usually found on the margins of the latest-formed mountains, i.e. those developed during the 'Alpine Storm' (p. 45). All over the world we find the oil fields flanking mountains raised during this period of mountain-building; whether in California, Oklahoma, Mexico, Venezuela, Rumania, Iraq, Iran, or Burma. There are, of course, a few exceptions ('which do not disprove the rule'); but these special conditions—formations folded into gentle domes along the flanks of the young mountains—are best met with along the eastern flanks of the Rockies. Here indeed are the most important oil fields at Turner Valley and at Leduc near Edmonton.

In Ontario a shallow well was dug at Oil Springs, 25 miles north of Chatham in 1857, and a deep well was sunk the same year, long before the famous well at Titusville, Pennsylvania. However, the first flowing-well at Oil Springs was not drilled till 1862; and the important Petrolia field (14 miles south-east of Sarnia) was discovered in 1865. The peak in oil production was reached in 1900, when over 900,000 barrels were obtained in this south-west corner of Ontario; but by 1943 the supply had declined to 143,000 barrels. The wells in this field are relatively shallow, mostly only a few hundred feet. The Onondaga of the Middle Devonian is perhaps the chief oil horizon, and is a grey bituminous limestone. It is stated that in 1898 there were as many as 8,600 wells producing oil, but the field is now of little importance. Huge pipelines now connect Edmonton with Vancouver and Winnipeg.

Turner Valley and Norman Wells

Much more important than Petrolia as an oil producer is the Turner Valley oilfield in Alberta, which accounts for more than 96 per cent of Canadian production.[1] The field is about 19 miles long, and the production has risen from 1·3 million barrels in 1936 to 10 million barrels in 1943. At the end of 1940 there were 130

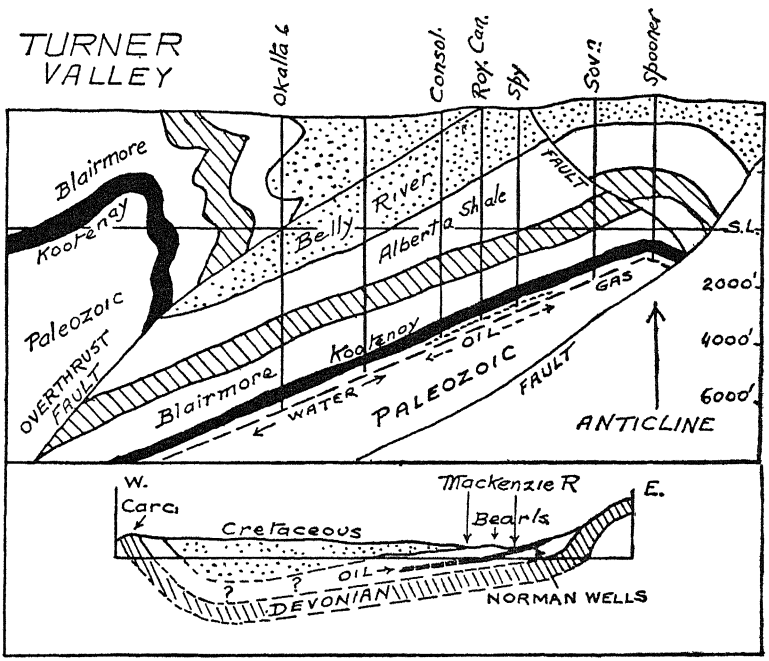


FIG. 133.—(*Above.*) A cross-section of the southern portion of the Turner Valley oilfield, with oil in Carboniferous rocks. Seven wells are indicated

(*Below.*) A cross-section of the new oilfield at Norman Wells. (Both after G. S. Hume)

producing wells in the Valley and the production was about 25,000 barrels a day. Most of the wells are over 3,000 feet deep, and the British Dominion well is 6,150 feet (Moore, *Mineral Resources*). The oil occurs in the Rundle limestones, the upper 350 feet of Mississippian age. Leduc (18 miles south of Edmonton) is a rich new area.

The geology of the Turner Valley Field is given by G. S. Hume in ' Petroleum Geology of Canada ' (*Geol. Bulletin 98*), Ottawa, 1944.

[1] ' Oil in Canada ', by R. A Davies in *International Oil*, Houston, July 1941.

The section charted in Fig. 133 is across the southern part of the valley, and shows the Cretaceous beds above and the Carboniferous below the oil horizon. In this locality the Belly River beds are 1,700 feet thick, and there is a coal seam at the top. Below these are the Alberta Shales, which are about 2,000 feet thick. They cover the Blairmore and the Kootenay. The oil horizon is just below the latter, on the flank of an anticline as charted. Gas collects at the top of the anticline, then comes the oil, while water is found still lower in the permeable beds. In general, the structure is that of a fault-block cut off by a major fault on both sides. The Paleozoic limestones below the oil show a westward dip of about 25 degrees. Good productive wells occur for 5 miles in the south end of the field and for 5½ miles in the north end. Between there is an area 9 miles long where production has been more uncertain, due to lack of local porosity in the reservoir rock. At the end of 1942 one well had produced nearly one million barrels and eleven additional wells had produced more than half a million barrels each. At the end of 1943 there were 217 producing wells. The crude oil contains more than 40 per cent gasoline on straight-run distillation (Hume).

The famous Canol Project aroused great interest during the war, since it seemed to offer a supply for military needs in Alaska, which could be delivered in the latter territory without incurring the danger of a sea voyage. The American Army took charge of the roads and pipeline which ultimately connected Norman Wells with Whitehorse on the Yukon River some 600 miles to the west (see p. 264).[1]

In 1914 T. O. Bosworth recommended three sites near what is now called Bosworth Creek. The first well was drilled in 1920, and obtained oil at 783 feet. In 1941 Imperial Oil distributed about 80,000 gallons of aviation gasoline, 112,000 gallons of motor fuel, and 230,000 gallons of fuel oil. After the Canol project was started, a number of new wells were drilled of which 23 found oil in commercial quantity. The field is about 3 miles wide and 5 miles long, and includes Bear Island in the centre of the 4-mile-wide Mackenzie River.

The structure of the field is simple (Fig. 133). On top of the Middle Devonian limestone is a coral reef, and this is the main reservoir rock. The reef is up to 425 feet thick. The dip of the strata is to the south-west at about 5 degrees. The wells on Bear Island are 2,000 feet deep. Thus here, as at Turner Valley, the oil occurs on the flank of an anticline, and this builds up the Norman Range just to the east of Norman Wells (Hume).

Near Waterways (Fig. 90) the Abasand Tar Company is quarrying the tar-sands, which contain about 15 per cent of bitumen. In

[1] For a good illustrated description of the 'Canol' project by O. B. Hopkins, see *Canad. Geog. Jnl.* for November 1943.

1941, 19,000 tons of sand yielded 17,000 barrels of bitumen. Considerable difficulty is experienced in separating the tar from the quartz sand, and the deposits are in isolated lenses, and often not rich enough to pay for exploitation. Other deposits occur farther north.

There are a number of small oil fields in the prairie region located in two main areas. Near Lethbridge are the Red Coulee, Taber, and Brooks fields; while farther north Wainwright (south-east of Edmonton) is the chief producer. In May 1949 there were 710 wells in Alberta, which could produce 70,000 barrels a day, if unrestricted.

The Thetford Asbestos Mines in the Eastern Townships (Quebec)

The first discovery of commercial asbestos was made in 1877, close to the present mines at Thetford in the far south of Quebec

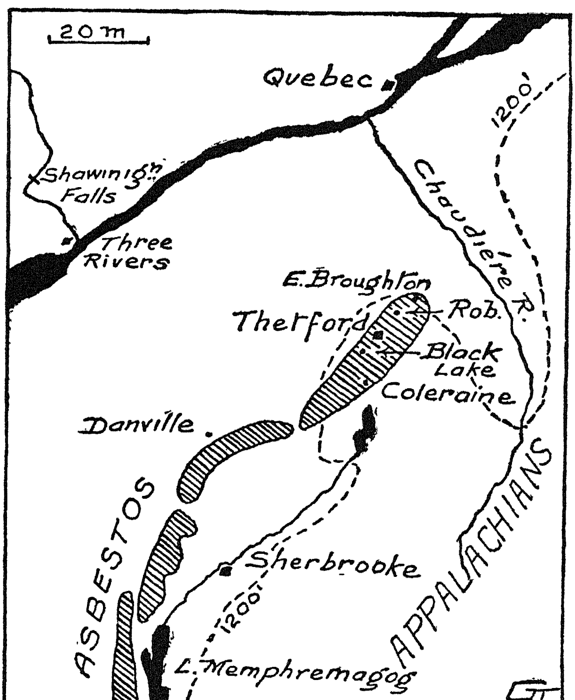


FIG. 134.—Asbestos areas in the eastern townships of Quebec

(Fig. 134). The deposits occur on the flanks of the Appalachian Fold Mountains, and three anticlines are salient features in this part of the province. The asbestos occurs in basic igneous intrusives on the eastern flank of the broad Sutton anticline. Here the dunites

and peridotites have been altered into serpentine, and this belt of serpentine extends for 100 miles along the sides of the Appalachians to the south-west of Thetford. There is some evidence that these intrusives are younger than the Cambrian, and Malcolm and Robinson (*op. cit.*) are inclined to date the serpentine as Early Ordovician.

The asbestos is of the chrysotile variety and occurs in the serpentinized peridotite. It is usually found in veins as cross-fibres; and these veins, several inches wide, may at times be traced for a hundred feet. Most of them follow the rectangular system of jointing which occurs throughout the dunite and peridotite. The overburden of till, &c., may have a thickness of 80 feet or so. This is stripped away, and the veins are worked in huge open pits laid out in wide benches.

The serpentine is crushed in mills which liberate the asbestos fibre, and the fluffy mineral is picked up by suction devices. The best product consists of fibres over half an inch in length, but all lengths down to one-twentieth of an inch are of commercial value. For asbestos textiles the fibres are for the most part over one quarter inch long. Medium fibres are used for sheet packing, while the shortest fibres are made into asbestos shingles, &c.

There are six districts, all close together, in the Thetford asbestos field. From north to south, these are East Broughton, Robertson, Thetford, Black Lake, Coleraine, and Danville. The centre of the field at Thetford is 60 miles to the north-east of Sherbrooke. In 1885 the seven quarries reported an output of 2,440 tons, and by 1945 this had increased to 467,000 tons. The power necessary at the mines is transmitted for 110 miles from the Shawinigan Falls across the St. Lawrence River. There were about 20 companies engaged in the industry, but many of them amalgamated in 1926.

The Wabana Iron Mines, Bell Island, Newfoundland[1]

In 1840 the geologist J. B. Jukes noted the bed of bright red sandstone on the rocky north-west side of Bell Island, which is 20 miles north-west of St. John's (inset in Fig. 135). But it was not till 1893 that any mining was done; and in 1895 the first cargo of ore left Wabana for Halifax, to be smelted at Ferrona near Pictou. In 1899 the Dominion Iron and Steel Co. purchased most of the ore deposits. About 1937 there were four mines working on the Wabana properties.

The island is about 6 miles long and 2 miles wide, and consists of Cambrian and Ordovician rocks, dipping gently to the north-west. The summit of the island is 390 feet above sea level, and the island is surrounded by cliffs rising steeply about 200 feet above the sea. Three workable beds of oolitic hematite outcrop on the north-west

[1] 'Mineral Resources of Newfoundland', by A. K. Snelgrove, *Geol. Survey*, St. John's, 1938.

side of the island, and like the interbedded sandstones and shales they dip 10 degrees to the north. The *Upper* bed of ore is about 6 feet thick, the *Middle* bed is 60 feet lower and is about 8 feet thick, the *Lower* bed is 240 feet lower still, and this bed is from 15 to 30 feet thick. Many of the workings are below the sea, and extend for more than a mile to the north of the island (Fig. 135).

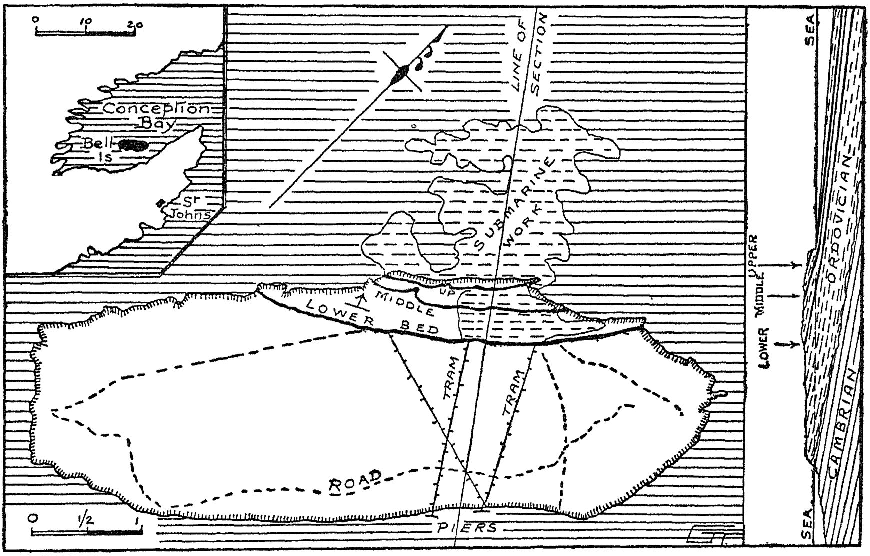


FIG. 135.—The Wabana iron deposits on Bell Island (Newfoundland), from a map by the Dominion Steel Company

The Wabana ore is composed of small concretions from one-half to one-tenth of a millimetre in size. The hematite contains about 52 per cent of iron, 12 per cent of silica, and 1 per cent of phosphorus; and is known commercially as a non-Bessemer red hematite. The ores are of sedimentary formation, and fossils indicate that they were accumulated on the floor of a shallow sea in Ordovician times. Hayes estimates that about 2,500 million tons may be found within the limit of submarine mining, about half of which is recoverable by present mining methods. Other estimates go as high as 10,000 million tons. The mines are located about 2 miles from shipping points, and ore is transported to the piers by three cable tramways. In 1937 the the mines employed a force of 1,930 men. The ore is smelted at Sydney, Nova Scotia.

The Steep Rock Iron Deposits in Western Ontario

One of the most remarkable mines in the Dominion is that which is just being developed at Steep Rock (Fig. 130), about 120 miles

west of Fort William, and only 75 miles north of the famous Mesabi Range iron deposits of Minnesota. The Steep Rock Lake is close to the Canadian Northern Railway at Atikokan, and the presence of iron ore on the shores of the lake has been known for many years. No outcrops however could be discovered in the vicinity, but in 1937 J. C. Cross began to drill the floor of the lake itself, taking advantage of the thick layer of ice which covered it in winter.[1] He found three major outcrops in the floor of the lake, which are labelled A, B, and C in Fig. 136.

Steep Rock Lake is an expansion of a rapidly flowing stream, the Seine River, which already had been utilized for power purposes. The Lake is now closed by several dams, and the Seine is deviated to another arm of Moose Lake, and then turned into a new course farther to the west, as shown in the outline map (Fig. 136). The

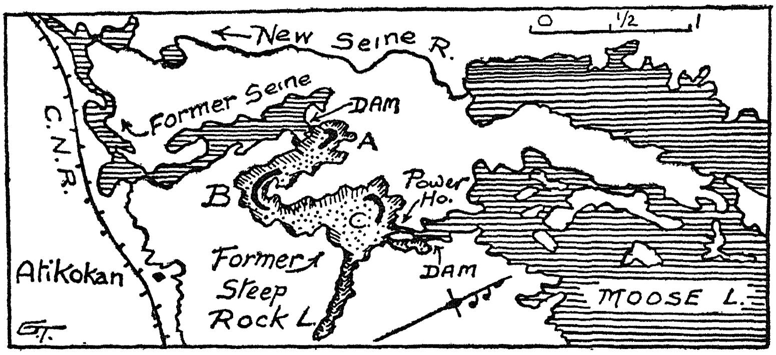


FIG. 136.—The iron deposits (A, B, C) in the drained lake (shown dotted) at Steep Rock in western Ontario. Looking to the west

diversion of the Seine River, the pumping out of Steep Rock Lake, which is 15 miles long and over 150 feet deep in places, the open-pit working of the ore in the floor of the lake, all these undertakings will require an outlay of $7\frac{1}{2}$ million dollars.

The ore deposits are of high-grade character, and it is anticipated that such ores will be in great demand by the steel makers of U.S.A., who are running short of such hard hematitic ores in their own territories. The ores are of Bessemer grade (containing about 60 per cent of iron) and are relatively free from phosphorus and very low in silica. Thus these ores will be of great value for mixing with others containing too much phosphorus and silica to be smelted alone. (In 1945 half a million tons were shipped to U.S.A.)

[1] 'The Steep Rock Iron Mine', by W. J. Gorman, *Canad. Geog. Jnl.*, November 1942.

PART III

GOLD, SILVER, COPPER, LEAD, &c.

Some general notes on the distribution of metallic minerals will serve to introduce this last section of the chapter dealing with Canadian mines. In modern text-books (e.g. Tarr's *Economic Geology*) a hypothetical section of the crust is given, showing a gigantic batholith (or boss) of igneous rock covered by layers of other rocks. The highly heated batholith is supposed to be the source of vapours or heated solutions which carry various metals towards the surface. Thus mercury and antimony are very volatile, and so are found *farthest* from the batholitic source. Silver, lead, and zinc tend to occur in an intermediate belt. Gold and copper are readily precipitated on cooling, and form an inner zone. Tin, tungsten, and molybdenum often seem to crystallize out in the margins of the granite batholith itself. As I have described in my companion volume on Australia, zones of minerals have been deposited around the granite batholiths of north-west Tasmania, in accord with this theory. Something of the same sort may be expected in connexion with the batholiths of British Columbia, though I have not come across very definite examples.

A second type of ore-deposit occurs without any apparent connexion with batholiths of deep-seated origin, though far below the surface there may be such a connexion. Often enough metallic ores are found along the junction of two *dissimilar* rocks, such as limestone and an igneous rock. Moreover, there is a tendency for the weathering of surface rocks (due partly to air, water, and weak acids such as carbonic acid) to have a considerable effect in concentrating the metallic contents of a lode or vein. The upper ores are dissolved and re-deposited lower in the rock. Such concentration is called 'secondary enrichment', and it is obviously more likely to occur in the surface portions of a large lode, than in the deeper portions of the deposit.

Finally, a third type, which is of considerable importance in many mineral fields, is due to the actual normal erosion of rocks containing insoluble ores such as gold or tin oxide, &c. The lighter portions, such as the quartz (gangue), are carried slowly down the gullies and streams, but the heavy gold or tin tends to collect below (but near) the site of the original vein or lode. Such deposits are called *alluvial* or *placer* deposits; and since they are easily mined, they are sometimes described as 'poor man's fields'. Examples of all these types, as well as many others, are found in Canada; and a number of important mines are described in which the ore deposition will be better understood after this preliminary explanation.

Cobalt and Porcupine Fields in Eastern Ontario

These two famous fields may well be considered together, since the Porcupine gold mines developed as a consequence of the Cobalt silver mines, some 100 miles to the south-east (Fig. 130). In 1903 a railway was being built to open up the country in the east of Ontario, and this passed along the west shore of Cobalt Lake. Many small mineral veins could be seen alongside the railway, and it was soon found that they contained rich silver. In 1905 2½ million ounces were obtained by hand from shallow surface pits, and this naturally led to a rush. The zenith of the field came in 1911, when over 31 million ounces of silver were taken from the various mines. By 1924 the Nipissing Company had paid 26 million dollars in dividends. In 20 years this field produced half as much silver as either Zacatecas or Guana-juato the famous Mexican silver mines which have been exploited for 300 years.

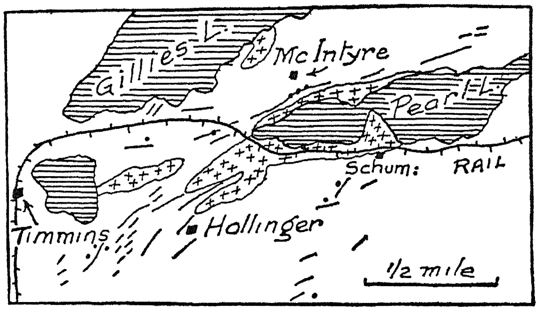


FIG. 137.—The Granite area near the Hollinger and McIntyre mines in the Porcupine Goldfield. The numerous veins appear as short lines, and porphyry is shown by crosses. The large dots are mine-shafts

The rocks of the Shield in this area consist of Keewatin series covered by the Cobalt fragmental rocks. These latter are mainly conglomerates and breccias, which have been intruded by diabase sills, &c. The silver ores were probably derived from the latter, and were deposited from solutions or gases in the fragmental rocks. Some geologists think that the latter are in part Pre-Cambrian glacial tills; and indeed to the writer they look much like the Cambrian tills of South Australia.

Canada ranks second among the gold-producing countries of the world, and this is largely due to the mines of the Porcupine field, together with those of the adjacent fields at Kirkland Lake and Rouyn (Quebec). As the Cobalt field became well established the prospectors naturally moved north along the new railway to Cochrane to test the rocks of the Shield farther from the settlements. The first discovery was made in 1908; and next year—within a few days—

three of the greatest mineral deposits in Canada were found, i.e. at Hollinger, McIntyre, and the Dome. Much of the money made in the silver mines of Cobalt was invested in the new Porcupine field to the north.

By the end of 1925, that is to say in sixteen years, Porcupine produced about 161 million dollars' worth of gold and 44 millions in dividends. The three chief mines in the field are Hollinger, Dome, and McIntyre, all of which lie within 4 miles of the east of the mining town of Timmins (Fig. 137). The orebodies of the camp are of large size, low to medium in grade, and are of a composite type. Many of the ore-shoots are over 500 feet long and several are over 1,000 feet. The ore in the deeper workings (which go below 3,000 feet) seems to show no falling off in grade or quantity (Malcolm and Robinson, *loc. cit.*).

These remarkable gold deposits in the Shield differ considerably from those described from Cobalt. There is here a suite of Pre-Cambrian rocks which are given in the following table:

FORMATIONS AT PORCUPINE

(Uppermost)	Pleistocene	Boulder clay, Peat, &c.
Pre-Cambrian	Keeweenawan Matchewan Algoman Haileyburian Timiskamian	Olivine diabase Quartz diabase Granite and porphyry with gold deposits Serpentine Conglomerates and quartzites
(Lowest)	Keewatin	Lava flows and chloritic schists

The gold deposits occur in close proximity to the porphyry stocks and veins. It is thought that the gold solutions ascended after the porphyry was solidified, and apparently after it had become somewhat schistose. Probably the gold is derived from the magma of the underlying granite rocks from which the porphyry itself was extruded.

Hence the deposits are essentially of Algoman age. Veins in many of the mines are linear for several hundred feet and very irregular in detail. When the quartz veins are numerous and closely spaced the whole of the intervening rock-mass may be well impregnated with iron pyrites. Gold occurs in these veins almost wholly in the native form, though at times it is combined with tellurium. The veins have a general north-east to south-west strike; and one cross-cut at 500 feet in the Hollinger Mine intersected ten veins in 800 feet.[1] Gold production in Ontario dropped from 106 to 67 million dollars during 1942–6.

[1] See the Ontario Dept. of Mines Annual Report for 1925.

The Klondike Placer Deposits—Yukon Territory [1]

In Chapter XI a description of the vicinity of Dawson City, and of the famous valleys of Bonanza and Eldorado Creeks, has been given. In this section attention will be drawn to the geological features of the deposits, which produced gold valued at 200 million dollars in the few years prior to 1902.

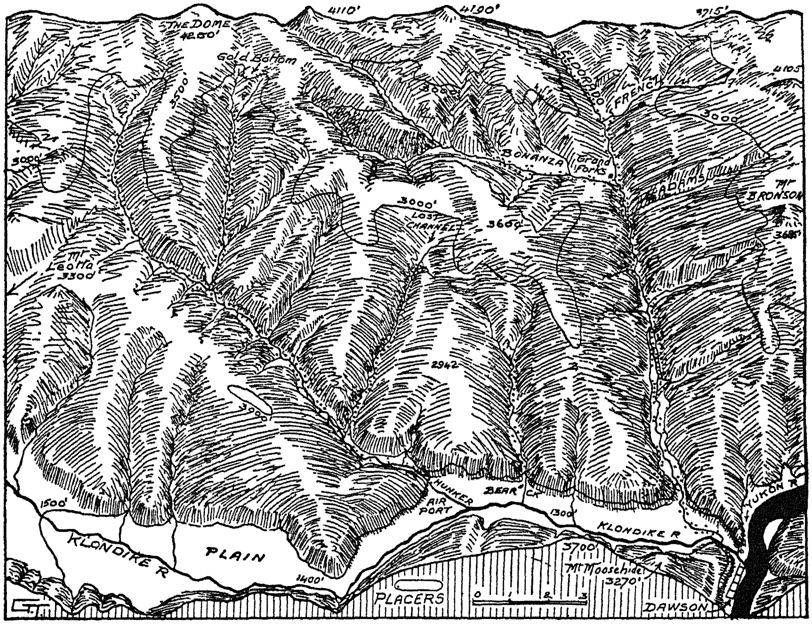


FIG. 138.—A block diagram of the alluvial goldfield at Klondike. Dawson City appears at the right front corner. Placer deposits shown by dots

The general features of the topography can be gathered from the block-diagram sketched in Fig. 138. Here we are looking south over the slopes of granite, which rise to a height of 4,250 feet at the 'Dome'. Dawson City appears in the lower right corner on the broad Yukon River. The town is at a height of 1,200 feet above sea level; so that the valleys sketched in the foreground of the diagram are cut down some 3,000 feet below the highest points of the rounded topography. The Klondike River flows in a flat plain a mile or more wide in places, in which the river meanders in the typical 'braided' fashion. Most of the slopes are covered with a bush of slender poplar and rarer spruce, but this thins out in the highest levels (Fig. 95).

[1] A valuable account of the development of the Yukon is given by H. A. Innis in his *Settlement and the Mining Frontier*, Toronto, 1936.

The auriferous gravels are shown in the sketch by the large black dots along a number of the valleys. Possibly the Bonanza valley from Grand Forks north to Dawson City contained the richest placer-mining that the world has seen. Hunker valley was also quite rich, as were two of its tributary gullies, i.e. Gold Bottom and Lost Channel. No vein gold of importance has been found, so that there seems little doubt that the gold is derived from auriferous veins which were originally in the rocks at a higher level long ago removed by normal erosion. The heavy gold has not, however, been carried downstream by the Yukon River, although this has been the fate of the silts and sands due to erosion of the accompanying rocks.

The *creek* gravels are the most important in the district, and floor the bottoms of all the valleys to a depth of from 4 to 10 feet. They rest on bedrock, usually consisting of schists, and contain the bones of extinct mammals, such as the mammoth, and of vanished animals like the buffalo and musk-ox. *Terrace* gravels, which are remnants of former valley bottoms, occur at higher levels. *High-level* river gravels are found which were laid down by the Klondike River when it flowed at a much higher level. These are over 150 feet thick in places, but usually do not contain much gold.

Some of the claims on Bonanza—an elevated creek-gravel type—yielded over half a million dollars each, or over $1,000 per running foot of valley. A claim at the mouth of Skookum Gulch (close to Grand Forks), only 80 feet in length, yielded over $300,000. Another claim at the mouth of French Gulch (also at Grand Forks) gave 1½ million dollars of gold.

The placer-gold is derived from the quartz veins in the older schists; and occurs in irregular flattened discs or bulbs, very similar, when unworn, to those in the veins. In the creeks the gold is much worn, but in the upper gulches it is rough and angular. However, a small percentage of the gold may have been precipitated from water carrying gold in solution.[1]

Near Grand Forks is a small gully heading in a pegmatitic hill in which valuable deposits of placer *tungsten* have been won. Another tungsten mineral (scheelite) has been found in payable quantities in the Mayo District (Fig. 95).

In recent years the gold has been won almost entirely by means of huge dredges—of which thirteen were operating in the vicinity of the Klondike before the war. These float in pools of their own excavating, and scoop up the once-worked gravels in huge steel buckets. The gravel passes over separating tables, and the tailings are deposited at the rear of the dredge. The power for these huge chains of buckets is provided from a hydro-electric plant on the north fork of the Klondike River.

[1] *The Yukon Territory*, Dept. of Interior, Ottawa, 1926.

Other Goldfields in Canada

Many other important fields besides Porcupine occur in Ontario, the chief being Kirkland Lake about 60 miles to the south-east. From these mines some 185 million dollars' worth of gold was obtained between 1913 and 1935. In this area the gold occurs along strong faults or brecciated zones in the belt of Temiskaming sediments, which have been intruded by masses of basic syenite. Lake Shore and Teck-Hughes are two of the chief mines.

A great number of mines were opened in Ontario in the 'thirties, some examples occurring near Lake Nipigon just north of Lake Superior. Among these are Beardmore, Kowkash, Little Long Lake, and Sturgeon Lake. Near Michipicoten (north of Sault St Marie) there is another group of mines in production. In the far north of Ontario are some new fields such as Pickle-Crow, Red Lake, and Woman Lake, which will be more fully exploited now that the war is over (Fig. 153).

Quebec has developed a number of very important mines just over the border from Kirkland Lake. The Noranda mines came into production in 1927, and since that date three other belts of promising mineralized rock have been discovered in this region. Today 40,000 people live in what was empty forest a decade or so ago. The chief mining towns are Noranda, Rouyn, Arntfield, Malarctic, Belleterre, Val d'Or, and Sullivan. By the end of 1942 this western section of the province had produced metals worth 447 million dollars, including copper, zinc, and silver, as well as gold. Pioneer mines are being opened up in the Chibougama and Opemiska areas still further east, in the almost unknown hinterland of the ancient Shield.

In the far north near Great Slave Lake there is an important group of goldmines in the Yellowknife Field. This area was first extensively prospected in 1934, and by 1938 the first gold brick was poured at the Con Mine. Mineral production amounted to 3·8 million dollars in 1942, of which about half came from the Con and Rycon mines. The labour shortage due to the war has almost stopped production in recent years.

The chief mines in the prairie provinces are found near Flinflon on the borders of Manitoba and Saskatchewan. Rice Lake and God's Lake in the north-east of Manitoba have been mentioned earlier (Fig. 86). There are no mines of importance in the Rocky Mountains proper, but the Jurassic batholiths of granite, which underlie the Selkirk and Coast Mountains, are fringed with important mines of gold, silver, copper, lead, and zinc.

In British Columbia gold is mined in both placer and lode deposits; placer chiefly in the Atlin, Caribou, and Quesnel districts; lode gold at various points, though the chief producer for

many years was the Premier mine on the border of Alaska. Considerable quantities of gold have been obtained from the copper ores of Copper Mountain (near Princeton), Britannia Mine on Howe Sound north of Vancouver, and Anyox, about 90 miles north of Prince Rupert. Zeballos on the west coast of Vancouver Island is a new field which promises well (Fig. 153).

The Sudbury Nickel Field

A very slight acquaintance with the rocks of the Shield shows one that they differ a great deal as regards their resistance to normal erosion. Near ' Go Home ' Bay on Lake Huron the writer has observed hollows of all sizes weathered out of the softer portions,

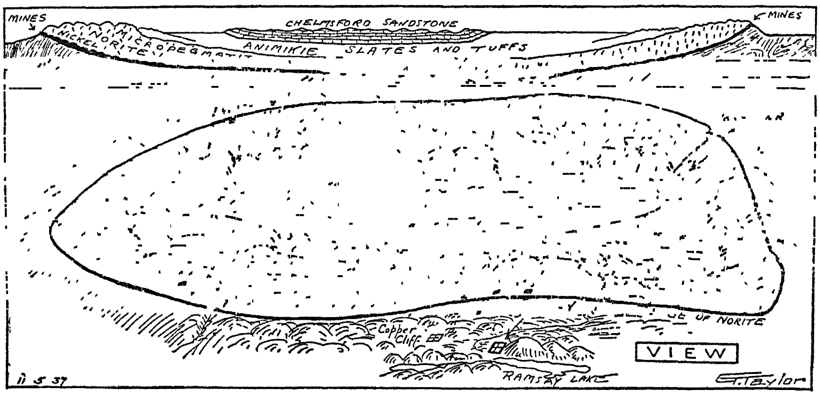


FIG. 139.—A block diagram of the Sudbury basin (30 miles long), eroded from the ancient rocks of the Shield. A vertical section through the syncline is given above. Creighton mine is 11 miles west of Sudbury. (From a model prepared under the direction of Professor E. S. Moore)

which in this case are the micaceous ' augen ' in Augen Gneiss. The hollows may be a foot across, or in other cases 20 feet across. One of the best-known examples of such erosion on a giant scale is the famous *syncline of norite,* with which is associated the nickel deposit at Sudbury. Its general structure is sketched in Fig. 139 from a large model in the Royal Ontario Museum.

To the north of Sudbury is a large canoe-shaped hollow, some 36 miles long from west to east, and about 16 miles across. This hollow is bounded by steep slopes several hundred feet high, which are composed of Pre-Cambrian rocks hardened by contact with eruptive rocks of later date. The latter (Pegmatite and Norite) welled up in a molten form from below, and then spread out in a vast boat-shaped mass, lifting up the softer Animikie slates. As the molten mass cooled, it is thought by some geologists that the heavy

nickel minerals fell to the lower parts of the molten mass. (The layer rich in nickel is shown *black* in the section above Fig. 139.) Hence the nickel mines are found all round the oval margin. (A later theory, however, links the nickel deposits with *faults* in the rocks, along which the nickel-bearing solutions impregnated the adjacent rocks.)

The Sudbury syncline is about 260 miles north-north-west of Toronto, not far from the shores of Lake Huron; and a number of railways connect the town of Sudbury with the rest of the province, and link the various nickel mines. The syncline has an area of about 550 square miles; and the softer slates, &c., in the centre are somewhat more fertile than the adjacent Shield, and are now devoted to farming. The Vermilion River flows into the syncline at Capreol and leaves it near the Vermilion Mine (in the south-west of the syncline) on its way to Lake Huron.

In 1883 chalcopyrite was discovered along the Canadian Pacific Railway, which was then being constructed from Montreal to Winnipeg. It is interesting to know that many of the early mines were worked for their copper contents, and nickel in any quantity was not suspected till 1887. Difficulties in smelting the copper ore led to the discovery of the nickel, which indeed was so named by the German miners who imagined an impurity added by a mischievous sprite or 'nickel'. (In the same way cobalt is the 'kobold', or goblin, metal.) The first smelter was started at Copper Cliff in 1888, evolving into a distinct smelting town some 3 miles to the west of the residential town of Sudbury. In 1918 the output of nickel was 46,000 tons, or 46 times as much nickel as the whole world produced when the Sudbury mines were discovered.

One of the chief sources of the world's platinum and palladium is the famous Vermilion mine, in which the copper and nickel values have been much higher per ton than in most of the other mines. In general the average nickel ores run about 3 or 4 per cent nickel, with somewhat lower amounts of copper. In 1927 it was stated that the Frood mine near Sudbury had reserves of sulphide ore amounting to 100 million tons, making it one of the largest known sulphide ore bodies in the world (Malcolm and Robinson).

The eruptive rock which contains the nickel is a norite or quartz-hypersthene gabbro. The inner edge of the giant sill (or 'canoe') consists of acid eruptives akin to micro-pegmatite. They are similar to the Nipissing diabases of Cobalt, and are probably of Keeweenawan age. The metallic minerals are chalcopyrite, which contains the copper, and *pentlandite*, which is the nickel mineral. These sulphides are in the form of strings of 'blebs' about the size of peas, and the containing eruptive rock does not seem to be much altered near them.

There are two main companies exploiting the nickel deposits,

i.e. International Nickel and Mond Nickel. The Creighton Mine has been the chief producer for the former company, and, it is situated 10 miles to the west of Sudbury. The ore is smelted to a matte, and then shipped to the refinery at Port Colborne at the east end of Lake Erie. The smelting plant of the Mond company is at Coniston, some 8 miles east of Sudbury, where they have built an attractive 'company town' for the benefit of the employees. Their chief mines are Garson (10 miles north-east of Sudbury), Frood a few miles north, and Levack, which is on the northern rim of the 'canoe' about 20 miles to the north-west of Sudbury. According to Malcolm and Robinson there are over 300 companies in U.S.A. and Canada using nickel to produce nickel-steels and other alloys of commercial value. Lynn Lake (Manitoba) produces much nickel.

The Sullivan Lead-Zinc Mine at Kimberley, South-East British Columbia

One of the largest lead-zinc mines in the world, and therefore one of the main mines in the Dominion, is the Sullivan Mine at Kimberley. It is situated in the Selkirk Mountains, about 50 miles north of the U.S.A. border; and is thus conveniently placed with respect to the Fernie coalfield (some 50 miles to the east) and the Trail smelters, which are 200 miles to the south-west (Fig. 65). Kimberley is almost on the great Rocky Mountain Trench, but the largest town in the vicinity, to the west of this feature, is Cranbrook about 19 miles south.

The mine was discovered in 1892, and a branch-line from the Canadian Pacific Railway reached it in 1899. Considerable difficulty was found in smelting the ores at first owing to the mixture of zinc and lead minerals, and the mine was closed in 1909. However, it was worked on a larger scale by the Consolidated Company after 1910, and by 1914 had become one of the largest mines in Canada, a distinction which it still holds.

The mining community centred on the Sullivan Mine is dispersed in various settlements (Fig. 140). In the deep valley of Mark Creek (whose waters enter Kootenay River) is the main adit of the mine at a level of 3,900 feet above the sea. This enters the side of Sullivan Hill (6,000 feet) in which is the ore body, and is over 2 miles in length. About 1,000 feet higher is another older adit, and workings many miles in length now honeycomb the mountain. Crushing mills, &c., are clustered near the main adit. Some 2 miles down the valley to the east is the main town of Kimberley, with the pretty little company village of McDougall built on a terrace immediately to the north, where many of the officials and men live. Then below Kimberley to the east is the Concentrator Plant, with another company village adjacent. The total population of these

settlements is about 3,000. The bulk of the ore and concentrates goes by rail to Cranbrook and thence to Trail, where the company has the largest smelting plant in Canada.

The rich ore deposits are somewhat unusual in their shape and character, and a remarkably interesting model of the deposit fills a small room in the company's office. Additions are made to this model as fresh workings are opened in the deposit. The model of the ore body is coloured red, and to use a homely simile, resembles nothing so much as a thick beef steak containing many irregular oval holes. The ore is actually a fine-grained mixture of galena, zinc blende, pyrite, and pyrrhotite, and in places the deposit is as much as 240 feet thick. The deposit dips to the east at an angle of about 23 degrees, and though it outcrops in the upper portion of Mt. Sullivan, its lower portion is buried deep under the flanks of the mountain (Fig. 140).

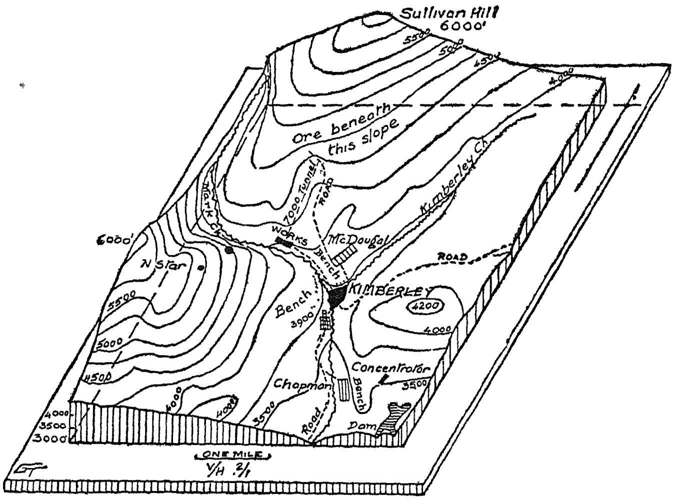


FIG. 140.—A block diagram of the Kimberley mining field, showing the settlements near the great Sullivan lead-zinc-silver mine. (From the *Geographic Review*, July 1942)

The Pre-Cambrian quartzites in the vicinity of the mine form the eastern limb of a large anticline. These quartzites are intruded by a series of sills of very varied composition. The lead-zinc deposits seem to be replacements in the argillaceous quartzites, and the ore body dips in accord with the anticline. The ore usually contains about 10 per cent of lead and the same amount of zinc, as well as 36 per cent of iron. Silver to the extent of 3 ounces to the ton is recovered from the ore.

Radium Mines of the Dominion

The Eldorado Mine on the eastern shore of the Great Bear Lake produces about 40 per cent of the world's radium. The silver-pitchblende deposits were discovered in 1930, but were not fully developed for several years. In recent years a modern mining and milling plant has been established in this locality, which is almost on the Arctic Circle. Boats connect with the Mackenzie River at Fort Norman. The mine is also linked with the south by fairly regular air services (Endpaper Map).

During the year 1939 the mine yielded 1,100 tons of concentrates, and a plant for refining the metal has been erected at Port Hope on the shore of Lake Ontario, about 80 miles east of Toronto. Silver, copper, cobalt, and lead, as well as radium and uranium, are recovered from the ores. The radium and uranium products in 1939 amounted to over 1 million dollars; but the output for the war years has been withheld from publication. As a result of this large output from the Eldorado Mine on Great Bear Lake, the world's price for radium has been reduced by 62 per cent, and that of uranium salts by about 37 per cent. The price of radium was about $135 per milligram in the last war, but dropped to about $27 in 1939.

World production of radium, since Madame Curie's experiments in 1898, aggregated about 1,000 grams by 1940. The St. Joachimsthal mines in Bohemia were important producers, giving about 5 grams of radium per year around 1938. United States, Belgian Congo, and Cornwall (England) are also producers of radium in smaller amounts.

Notes on Mines of Silver, Copper, Lead, &c.

Silver production in Canada attained its maximum in 1910, when some 33 million fine ounces were produced, chiefly from the famous Cobalt field described earlier in this section. Previously Silver Islet near Port Arthur had been a great producer, and from 1869 to 1885 about 4 million ounces were obtained from this district. Today the Sullivan Mine at Kimberley (already described) is the chief producer of silver, as well as of lead and zinc. However, a good deal comes from the Yukon, especially from Mayo, and the total production to the end of 1943 from this region has been worth 21 million dollars. Silver also accompanies various gold ores, and is found in the pitchblende ores of Great Bear Lake. Canada ranks third among the world's producers of silver, though it is far behind Mexico and the United States. (Peru now rivals Canada.)

Canada is one of the chief *copper* countries ranking after United States and Chile, but having a close rival in Rhodesia. From 1898 to 1929 British Columbia was the leading province, chiefly from the

Rossland mines and those at Copper Mountain and Britannia. But in 1930–1 both Quebec and Ontario outstripped the former province, while Flinflon has brought Manitoba into the same rank as British Columbia in the last few years. Noranda and Sudbury are two fields where the copper is quite important, though they are usually associated with gold and nickel respectively.

Almost all the *lead* produced in Canada comes from the Sullivan Mine already described, and no other province has 1 per cent of the production from this one mine. Galetta near Ottawa and Mayo in Yukon are of secondary importance. *Zinc* also comes mainly from Sullivan, since it produces 70 per cent of the metal; but mines near Rouyn (Quebec) and Flinflon (Manitoba) give Canada quite large amounts of zinc.

Recent Mineral Developments

Mineral production has doubled in value from $660 million in 1947 to $1,331 million in 1953. This is due to the discovery of many new mining fields, and especially to the great number of new oil areas which have been successfully exploited. Leduc oil was discovered in 1947 near Edmonton, and now a vast oil-producing formation in Lower Carboniferous rocks is believed to underlie the south-west portion of the Prairie Provinces. Thus wells are producing oil and gas to the south-west of a line (1,200 miles long) from Virden (near Winnipeg)—extending to the Peace River area in British Columbia. This Williston basin has an upturned rim along the line mentioned. It is capped by younger less permeable formations, which seem to have prevented the oil from escaping from the Carboniferous strata in the oil-retaining rim. (*Yearbook*, 1955.)

The 360-mile railway from Sept Iles to the Labrador Iron mines was built by 1954, and a new town of Schefferville has arisen at the northern end. At Allard Lake, not far from Sept Iles, is one of the largest sources of titanium in the world. Across the St. Lawrence Gulf, copper deposits of great value are being worked near Gaspe, and power is being carried across the Gulf to the mines from the Bersimis power plant (p. 378). Lead-zinc deposits have been exploited near Bathurst (New Brunswick).

Proceeding west we find considerable deposits of iron at Marmora near Peterborough (Ont.); while uranium is being worked at Bancroft nearby. About 40 miles north of Lake Superior valuable copper-zinc ores have been found at Manitouwadge. Nickel-copper is mined at Lynne Lake (Man.), where a whole town has been transported from Sherridon 144 miles south. Beaver Lodge in North Saskatchewan is one of the best of the hundreds of sites where uranium ores are being worked.

CHAPTER XVIII

MANUFACTURES AND TRADE

Industrial and Manufacturing Development

I FEEL that I cannot do better in introducing this important section than by quoting from an article with the above title by F. S. Keith in the *Engineering Journal* for June 1937. He comments on the industrial conditions in 1887—some fifty years ago—as follows:

> In 1887 Canada was in a period of depression, but the gross value of manufactured products was around 400 million dollars in 75,000 establishments. During the year 84,000 settlers arrived in Canada, and Toronto had a population of only 66,000. Vancouver had just been burnt out, and the population of 2,000 was living in tents. The steam engine and small water powers turned the wheels of industry. The electric light had made its appearance in the streets of Montreal the previous year, and was a novelty. There were 13,950 telephones in Canada, and most homes were illuminated with coal-oil lamps. Highways were not surfaced and sidewalks were of wood, and the high-wheel bicycle was a proud vehicle for touring and racing. The business woman had not arrived, and the well-dressed woman wore a bustle. Manual labour earned less than one dollar a day, and the typewriter was a newcomer. There were no gramophones, wireless, kodaks, movies, radios, aeroplanes or submarines, no electric house-appliances and no air-conditioning. Rugged individualism flourished, and sixty hours was the minimum week's work.

Keith divides the period since then into various eras, each with special characteristics. In the 'seventies cheese factories made rapid growth, and pork-packing was transferred from the farm to the factory. McKay sewing processes transformed the shoe industry. In proportion to population Nova Scotia led the world in shipbuilding. In the early 'eighties Canada enjoyed good harvests, and railway construction boomed. Roller-milling processes were introduced about this time. The last five years of the 'eighties were times of depression and discord (Fig. 141).

The prosperity of the 'nineties brought about great increases in the production of leather goods, cotton, agricultural implements, woodpulp, and household effects. Factories grew rapidly, and many new combinations in industry were formed. Electricity revolutionized production, but industries founded on farm products continued to have the greatest value. Tobacco, hosiery, and factory clothing all increased in importance. Carbide and carborundum

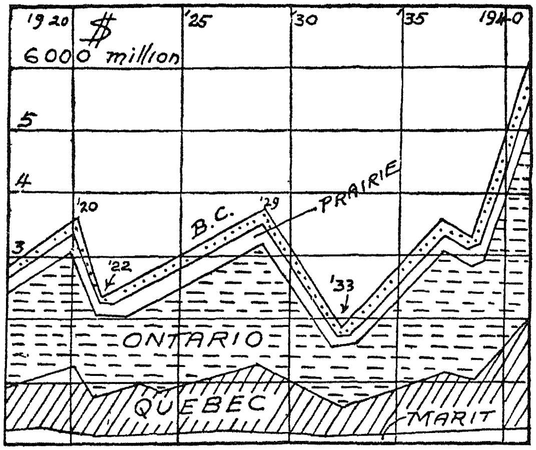


FIG. 141.—Gross Values of Manufactures, 1917 to 1941. Notice the depressions of 1922 and 1933. (*Canadian Year Book*)

(based on hydro-power) were largely produced in Canada, while the manufacture of motor-cars was initiated in this period.

The industries of the Dominion include such a vast field that only those aspects pertaining to distribution can be considered in this brief account. The fluctuations in the values of manufactures during the last quarter of a century are shown in Fig. 141. The depressed periods around 1922 and 1933 are clearly indicated, as well as the tremendous increase in manufacturing which marked the recent war years. It is also clear that almost all the manufacturing of importance is carried out in Ontario and Quebec, and this is shown more accurately in the following table (in million dollars, for 1952).

Province	Net value of products	Percentage
1. Ontario	$3,811	53
2. Quebec	2,289	31
3. British Columbia	556	7
4. Manitoba	217	3
5. Alberta	178	2
6. Nova Scotia	131	2
7. New Brunswick	118	1
8. Saskatchewan	81	1
9. Newfoundland	56	—
10. Prince Edward Island	6	—
11. Yukon and Territories	1	—
Total	7,444	100

The dominant position of Ontario is peculiar when one realizes that this province possesses no coal or oil fuels of importance. Its important position in regard to hydro-electric power has, however, been discussed in an earlier chapter (p. 374). A major coal-producing province is Nova Scotia, but this only gives it fifth place in the above list, while British Columbia, with only one-third as much coal-production, is very much more important in manufacturing. It is worth noting that the coal resources of Alberta, which are perhaps greater than those in any other province, have not yet been utilized to any notable degree.

LEADING INDUSTRIES IN CANADA, 1942 and 1952

1942 (war)			1952		
Industry	Net Values (million dollars)	Establishments	Industry	Values (million dollars)	Establishments
1. Shipbuilding	$166	79	1. Steel products	$1,134	2,625
2. Pulp and paper	165	105	2. Food	1,092	8,263
3. Chemicals	126	194	3. Transport	778	617
4. Non-ferrous smelting	126	16	4. Paper	736	543
5. Electrical	113	225	5. Wood	534	12,467
6. Machinery	104	255	6. Non-ferrous	415	552
7. Aircraft	104	42	7. Chemicals	414	1,075
8. Primary iron	103	61	8. Clothing	405	3,011
9. Steel products	92	168	9. Electrical	396	401
10. Sawmills	91	5,277	10. Printing	327	4,124
11 Automobiles, &c.	83	101	11. Textiles	313	918
12. Copper products	76	149	12. Coal and oil	226	101

Canadian industry has been changed almost out of recognition by the war needs of the army. Hardly any of the pre-war industries (except paper and non-ferrous smelting) which ranked high in 1932 are of the first importance in the 1942 statistics. We may perhaps fairly assume that the great increase in manufacturing shown in the preceding chart (Fig. 141) is largely made up of these ' newcomers ' into first-rank industry. It will be noticed that they are almost all mineral products, based on iron or copper, and as one would expect products based on peaceful needs, such as food, transport, paper, and wood, have moved up into front-rank positions.

Keith in the paper quoted previously points out that Canada, just before the war, led the world in the production of such materials as asbestos, newsprint, and nickel. In copper and zinc she occupied third place, fourth place in gold and lead, and fifth place in the manufacture of automobiles. In *exporting*, the Dominion was first

in wheat and second in wheat flour, third in automobiles, and fourth in the export of rubber tyres and wood pulp. In 1936 she advanced to fourth place among the trading nations of the world, and to fifth place in total trade.

General Distribution of Canada's Factories

In earlier chapters a good deal of information as to the distribution of the factories in some of the main industries has been given. For instance the pulp- and paper-mills are charted approximately in Fig. 117, and it is clear that they are found mainly in a belt extending along the southern edge of the Taiga from Winnipeg to Halifax. There are naturally not many to the west of Winnipeg, until the easy transport of the Pacific Ocean is available, where there are many factories developing near the fine forests of the Pacific coast. Saw-mills have been described in Chapter XV. Fish canneries have a similar well-defined distribution, along the Atlantic and Pacific coasts almost wholly. The major centres of hydro-electric power have a great bearing on factory life in Ontario and Quebec, and these have also been discussed earlier (Fig. 118). It would be impossible to chart the innumerable grist mills through the Dominion, or the equally numerous elevators, which are a striking feature in the wheat industry; though the elevators are naturally found mainly in the prairies, and along the great transport routes for wheat as at Fort William, Goderich, Montreal, and Quebec.

A rapid survey of the development of some of the remaining industries will be of interest. For instance, the manufacture of sawn lumber is carried on by over 3,000 mills; from the gigantic affairs of the Pacific coast (cutting as much as half a million feet board measure in a shift) to little custom mills on the Gaspé Peninsula operated by windmills, and cutting one or two thousand feet a day with favourable winds (F. S. Keith).

In the early days of the French regime almost every house had spinning-wheels for flax and wool and a loom; but by 1850, in Eastern Canada, there were 385 carding and fulling mills and about 250 establishments where weaving was carried on, in addition to the work done on the looms in the private houses. By 1891 the *home* production had dwindled to 4,300,000 yards, of which one-half was made in Quebec.

Woollen mills on a large scale developed first in the Eastern Townships, especially at Sherbrooke, but Cobourg and Galt in Ontario were also well supplied with woollen mills. In 1920 woollen goods to the value of 28 million dollars were produced, and the industry has somewhat declined in importance since that date. Today there are 104 woollen factories, 49 for cotton, 180 for knitted goods; and 34 silk and rayon establishments. Cornwall (Ontario)

and Drummondville (Quebec) are the chief centres for the new developments of rayon.

A discussion of other important industries follows, where they are considered province by province. However, it seems convenient to introduce the discussion of the *Steel* industry and the distribution of *imported coal* after the Eastern Provinces have been considered. So also the *movements of wheat* are charted at the end of the section on the prairie provinces.

Manufactures in the Maritime Provinces, 1941

The relative values of the industrial efforts of the various provinces can best be ascertained from the tables given in the *Year Book* for 1941. These are briefly discussed in this section. (Gross values are given in thousand dollars.)

	Factories	Men	Value
Prince Edward Isle :			
1. Butter and cheese	29	129	$1,226
2. Fish-curing, &c.	63	237	639
3. Printing	4	110	195
4. Fruit	5	64	190
5. Bread	13	52	176
6. Starch	4	21	154
7. Sawmills	53	99	131
Nova Scotia :			
1. Iron and Steel	6	3,257	24,403
2. Fish-curing	152	2,279	10,075
3. Shipbuilding	14	2,150	8,475
4. Sawmills	490	2,659	6,291
5. Pulp	5	833	6,209
6. Butter	28	439	4,471
7. Biscuits	6	1,079	3,848
New Brunswick :			
1. Pulp	6	2,914	28,613
2. Sawmills	292	3,763	11,235
3. Foods	7	309	5,705
4. Cotton	3	1,167	5,128
5. Fish	95	1,043	4,165
6. Butter	35	312	2,917
7. Biscuits	6	728	2,463

From these tables it will readily be gathered that Prince Edward Isle is of little importance in the industrial field, for even as regards butter and cheese factories, its small area makes it of much less importance than are the other two provinces in the Maritimes. The same comparison to an even greater extent can be made with regard to fish-curing. As regards Nova Scotia the outstanding importance

of the steelworks at Sydney is clear from the large values of steel produced in that province. The recent increase is largely due to the war; and the same may be said of the shipbuilding, which has third place in Nova Scotia. Pulp and paper, sawmills, and fish-curing are, however, industries of more permanent type, but their distribution has been discussed in earlier chapters.

Manufactures in Quebec

The many resources of Quebec have already been explained, but too much emphasis can hardly be laid on the value of the great waterway of the St. Lawrence, which has led to the growth of Quebec,

LEADING INDUSTRIES OF QUEBEC AND ONTARIO, 1952

	Factories	Men (thousands)	Gross Values (millions)
Quebec			
1. Pulp and paper	55	24	$508
2. Non-ferrous	8	10	318
3. Petroleum products	8	3	265
4. Slaughtering	39	4·5	189
5. Railway	9	17	159
6. Men's clothing	347	19·6	157
7. Women's clothing	525	18·6	148
8. Cotton	23	14	141
9. Tobacco	33	7	129
10. Butter	721	5	116
11. Electrical	36	12	106
12. Aircraft	18	15	103
Ontario			
1. Automobiles	12	30	$751
2. Primary steel	24	23	387
3. Non-ferrous	7	10	349
4. Pulp and paper	44	19	343
5. Slaughtering	61	9	341
6. Motor parts	98	20	266
7. Rubber goods	39	15	234
8. Electrical machinery	36	24	224
9. Agricultural implements	35	17	193
10. Petroleum products	13	5	171
11. Fruit	215	10	140
12. Butter	544	8	136

and to an even greater degree of Montreal. As a result of the war the immense resources of hydro-electric power have for the first time been rapidly developed, giving rise to new industries such as the production of the metal aluminium at Arvida. Petroleum-refining has also greatly advanced in importance in the last few years.

Quebec province is the second as regards manufacturing, with paper and pulp in the dominant position. In other products Quebec also ranks high, producing 87 per cent of the processed tobacco, 72 per cent of the cotton goods, 68 per cent of the women's clothing, 61 per cent of the boots, 58 per cent of the men's clothing, and 47 per cent of railway rolling-stock. These large totals in part depend on the lower wages which obtain in the French portion of Canada.

Montreal is the leading city of the Dominion in regard to the gross value of its industrial products, which total 803 million dollars, as contrasted with Toronto's 757 million dollars. It has, however, *fewer* factories, i.e. 2,669 as opposed to 3,045 in Toronto. In 1938 the following were the most important goods produced in Montreal:[1]

FACTORIES AT MONTREAL, PERCENTAGES OF TOTAL VALUE PRODUCED

1. Women's clothing	8 per cent	6. Electrical goods	4 per cent
2. Rolling-stock	7 " "	7. Breweries	3 " "
3. Tobacco	7 " "	8. Boots	2·5 " "
4. Abattoirs	6 " "	9. Printing	2 " "
5. Men's clothing	5 " "	10. Biscuits	2 " "

Quebec City ranks next to Montreal with 307 factories, and then there is a large gap until towns like Sherbrooke (74 factories), St. Hyacinthe (67), and Three Rivers (58) are listed.

Manufactures in Ontario

In Ontario there are far more industrial centres than in Quebec; where, as we have seen, only two large cities are of much importance. In addition to Toronto, which possessed 3,045 establishments in 1941, we find the following industrial towns all more important than any of the Quebec cities except Montreal and Quebec:

NUMBER OF FACTORIES IN ONTARIO, 1941

Town	Factories	Men	Town	Factories	Men
1. Toronto	3,045	133,000	5. Kitchener	151	12,000
2. Hamilton	491	45,000	6. Ottawa	203	9,974
3. London	234	12,000	7. Brantford	111	10,000
4. Windsor	223	29,000	8. Guelph	90	6,000

[1] J. Delage, *Montreal Economique*, Edition Fides, Montreal, 1943. Percentages are based on Montreal totals.

The character of the industries in Toronto may be gathered from the following table, given by J. Delage in the 1943 memoir cited:

INDUSTRIES IN TORONTO IN 1938

(*per cent of value*)

1. Abattoirs	10·8 per cent	5. Printing	3·2 per cent
2. Electrical apparatus	6·4 „ „	6. Bread	3·2 „ „
3. Biscuits	4·4 „ „	7. Machinery	3·2 „ „
4. Men's clothing	4·0 „ „	8. Women's clothing	3·0 „ „

This table does not of course give the enormous values represented by the war industries which have recently been developed in the vicinity of Toronto. The large aircraft plants are referred to in another section. The steelworks at Hamilton are also described elsewhere, with a map (Fig. 143). Among the minor factories indicated in Fig. 143 at Hamilton are the following: cotton and woollen goods, agricultural machinery, tobacco, electrical cables, clothing, trucks, rubber goods, stoves, ploughs, boots, and furniture. Windsor is representative of these small industrial cities, and here are to be found factories producing automobiles, drugs and chemicals, bridges, forgings, drills, clothing, textiles, paints, distilleries and breweries, machinery, &c.

The table on p. 452 shows that Ontario produces rather a different class of goods from Quebec. Apart from paper and non-ferrous products, hardly any of the commodities given in the parallel tables are the same. Many metallic materials bulk high in Ontario's list, such as automobiles (and tanks), automobile supplies, primary iron, machinery, sheet metal, and iron castings. No doubt a number of these will be of less importance now the world is at peace.

Since Ontario, like Quebec, has no coal of value, it is interesting to see where the coal originates which is used in such large quantities in these industries. Thus in 1942 57·6 per cent of the coal used in Canada was imported, almost wholly from the United States, while 42·4 was derived from Canadian mines. In Fig. 142 is given a map, derived from M. Eichmeier's study of the Canadian Prairies (*Amerikanische Landschaft*, Berlin, 1936), which shows that the major industrial regions in Canada depend on U.S.A. coal, where they do not utilize local hydro-electric power. Most of the heating of the houses in this part of Canada—which is necessary for eight or more months in the year—is based on coal from the Appalachian mines, though Welsh anthracite is much appreciated, and constitutes about one-tenth of the whole import.

Not much Nova Scotia coal from Glace Bay, &c., reaches

Montreal or Toronto, though it is used in eastern Quebec and the Maritimes (Fig. 142). In the Prairies the abundant coal from the mines at Lethbridge and Drumheller is widely utilized, and this same type of coal is found in Fernie, and serves the mines and folk

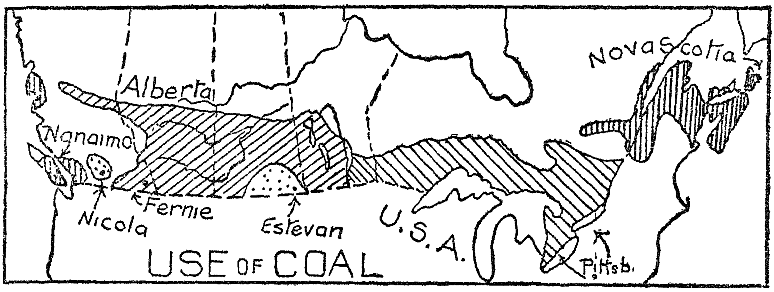


FIG. 142.—The six coalfields from which coal is derived, and the districts to which it is distributed. (From M. Eichmeier.) (Coal towns are large black dots)

in the south-east of British Columbia. Two local fields at Estevan and Nicola have a very restricted distribution as shown by the dotted areas in Fig. 142. The Nanaimo coal is also used locally, and is sent by sea up the coast to Prince Rupert.

The Steel Industry in the Dominion

The steel industry even before the war ranked high among the manufacturing activities of the Dominion. In 1935 there were close to 100,000 employees, and the annual value of the products was about 400 million dollars. A complete account of the rise of the steel industry is given by D. Killikelly in the *Canadian Geographical Journal* (for May 1938), from which much of the following description is borrowed. The first iron furnaces were built at St. Maurice near Three Rivers (Q.) in 1730, but the plant was not successful for a decade or so. However, the forges were in continuous use thereafter until 1883. Many short-lived attempts to manufacture iron were made near Gananoque (Ont.) in 1800; at Normandale (Ont.) from 1815 to 1847; at Marmora (Ont.) in 1830.

One of the earlier steelworks on a larger scale was built at Londonderry (near Truro, N.S.) about 1850; and a number of blast furnaces and Siemens hearths were constructed here. However, the plant closed in 1913. Rolling-mills based on *imported* billets of iron were established in Montreal as early as 1838, followed by others at St. John and Toronto.

The modern type of plant may be said to have been initiated in 1895, when a large furnace was built at Hamilton (Ont.), which

is still in operation. About this time there were only six furnaces producing iron in Canada. In 1898 the large plants at Sault St. Marie (' Soo ') began operations, and in 1899 the Dominion Steel Company was formed in Nova Scotia. These are today by far the most important plants in the Dominion.

At Sydney (Cape Breton Isle) when the war started there were three blast furnaces, twelve open hearth furnaces, and one 20-ton electric furnace. In addition there are coke ovens, blooming mills,

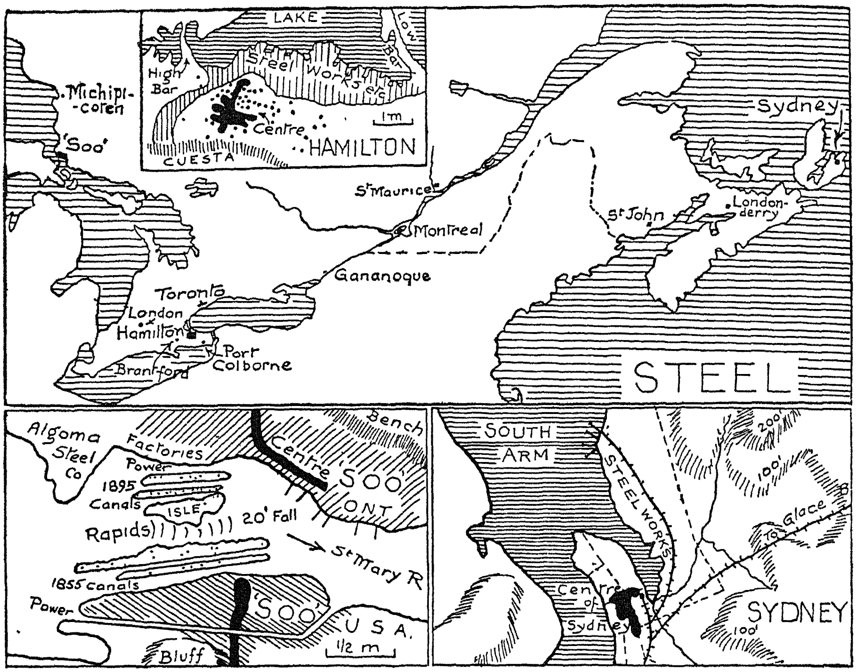


FIG. 143.—The distribution of the chief Steel Works; at Sydney, Hamilton, and Sault St. Marie (' Soo '). In the Hamilton inset map the small factories (shown by dots) are based on J. W. Watson

and rail and nail mills, all situated on the east side of the harbour away from the city of Sydney (Fig. 143). This huge company operates mills at Trenton (N.S.), Montreal, and St. John (N.B.). The choice of Sydney for the blast furnaces depended on the proximity of the extensive seams of coking coal at Glace Bay and elsewhere. The ore comes from Wabana (Newfoundland).

The various steel-making and steel-using units at Hamilton were amalgamated in 1910 to form the Steel Company of Canada; which in 1938 covered 319 acres on the foreshore of Lake Ontario adjacent to the city of Hamilton. It is stated that it manufactures a greater

diversity of products than any other steel company on the continent, including, for instance, putty, white lead, and lead shot.

At Hamilton there are two blast furnaces, eighty by-product ovens, eleven open-hearth furnaces, and more than half a dozen rolling-mills, for producing bars, sheets, rods, &c. This large company has branch plants at Brantford, Toronto, Gananoque, and London, as well as three near Montreal.

The various companies at Sault St. Marie amalgamated in 1912 to form the Algoma Steel Corporation. Their ore came from Minnesota, and in part from Michipicoten (Ont.) in the vicinity, the limestone from Michigan, and the coke from West Virginia. Here there are four blast furnaces and twelve open hearth furnaces, and the plant occupies 185 acres to the west of the Canadian city, just above the rapids. Apart from these three giant corporations, there is a small steel company operating one blast furnace at Port Colborne (Ont.).

A few words may be given to the aircraft plants which have been of such vital importance in the war effort. A brief report of their work has been published by R. P. Bell (*Canad. Geog. Jnl.*, March 1942), which records that the first aeroplane to fly in the Empire rose into the air off the ice of Baddeck, Nova Scotia, on 23rd February, 1909. At the outbreak of the war in 1939 there were ten companies engaged in making planes or their engines. At Montreal the Fairchild, Noorduyn, Vickers, and Car and Foundry firms were all soon engaged in this effort. At Toronto are the De Havilland Co. and the Victory Aircraft (both in the outlying district of Malton). Ottawa, Hamilton, Fort Erie, Fort William, and Vancouver all have plants engaged in the enormous aircraft production of the Dominion.

Industry in the Prairie Provinces

In Manitoba as might be expected the chief industries are connected with the processing of farm products. Slaughtering and meat packing (with ten plants) is the leading industry, while butter and cheese factories (totalling ninety plants) rank second. There are nearly forty flour and feed plants, and these added to the two former types, constitute 50 per cent of the industry (see following table). Among less-important plants may be mentioned beet-sugar refining, breweries, leather tanning, milk powder, cotton and jute bags, furniture, &c. &c. The manufacture and repair of railway rolling-stock is also quite an important branch of Manitoba industry.

Among the more interesting recent developments in Saskatchewan is the plant at Moose Jaw which produces glucose and starch from wheat. Another at the same town extracts vegetable oils from flax

STATISTICS OF INDUSTRIES IN THE PRAIRIE PROVINCES, 1952

(Factory shipments in million dollars)

	Factories	Value
Manitoba		
1. Slaughtering	14	$112
2. Rolling stock	4	39
3. Flour	8	28
4. Butter	72	27
5. Petroleum products	4	25
6. Men's clothing	49	22
Saskatchewan		
1. Petrol products	8	50
2. Flour	11	44
3. Slaughtering	9	36
4. Butter	60	28
5. Breweries	5	10
6. Bread	88	9
Alberta		
1. Slaughtering	11	110
2. Petroleum	14	81
3. Flour	41	44
4. Butter	102	32
5. Sawmills	909	24
6. Planing mills	115	21

and rape seeds. Rock wool is made here, and there is also a new Government woollen mill. At Swift Current is a plant for producing horse-meat (for export to Belgium), which will use up the surplus of horses due to the increased use of tractors on the prairies. The widespread white clays of the province are being used for pottery, &c., at Estevan, Clay Bank, and Saskatoon. At the latter city is a large egg-drying plant.[1]

In Alberta, Medicine Hat has many factories, some producing pottery and glass. Woollen mills are in operation at Magrath, while vegetable canneries are found here and at Taber nearby. There are huge works for the repair of rolling-stock near Edmonton; and at the same town is one of the largest clothing factories in the Dominion. Condensed milk is made at Red Deer; and cheese factories are scattered throughout the province. At Exshaw in the Rockies is a large cement plant.

Considering the three provinces as an economic group, slaughtering and meat-packing have the largest production, followed by butter and cheese, and then by flour-mills. These three industries

[1] See the interesting articles on these topics in 'Canadian Enterprise in Manufacturing', published by *Industrial Canada*, Toronto, 1945.

account for 43 per cent of the total manufacturing production (*Year Book*).

The Movements of the Wheat Crop, 1937–8

One major industry of the Prairies is the shift of the wheat crop, which may be considered in this chapter, though it belongs equally well in the section dealing with transport. The essential features are shown in the diagram given in Fig. 144 which is taken from the *Canada Year Book* for 1939.

The wheat crop in the Prairies (Western Division) during the year August 1937 to July 1938 amounted to 158 million bushels. This figure is shown at the left of the diagram (Fig. 144). A carry-

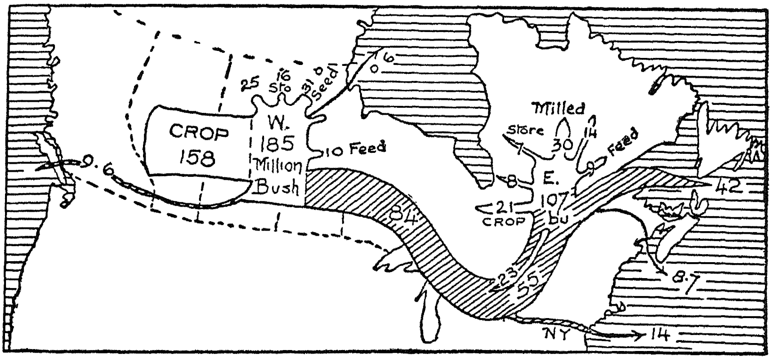


FIG. 144.—The movements of the Wheat Crop after the 1937–8 harvest. (From the *Canadian Year Book*)

over of 25 million bushels from the previous crop-year brought the total stock to 185 million bushels. About 84 million bushels were shipped from the head of Lake Superior from the giant elevators at Fort William and Port Arthur. Of this large amount about 12 millions entered U.S.A. ports (such as Buffalo) on the lakes. A good deal was transhipped at Canadian lake-ports (such as Port Colborne which took 15 million bushels for transfer through the Welland Canal), while other large amounts went by *rail* to Montreal, &c. Vancouver only shipped 9·6 millions in 1938, though the previous year the export had been 32 million bushels. Prince Rupert exported 1 million, while New Westminster and Port Churchill sent away about half a million each.

Much of the wheat remained of course in the country. Thus in the west *seed* requirements amounted to 31 million bushels, and 10 millions were used as *food*. About 16 millions were held in stock at the end of the year.

There is a good deal of wheat grown in the east of the Dominion,

and this amounted to 21 million bushels. This, added to the wheat received from the west, amounted to 107 million bushels. Of this large amount some 42 millions were exported down the St. Lawrence in the open season, while about 8 millions left by the winter-port of St. John.

Industry in British Columbia

Although this province ranks low in agriculture it takes third place in manufacturing. This is partly due to the abundant timber in the extensive forests, so that sawmilling in 1941 accounted for 20 per cent of the production. The relative importance of the other industries in this year can be seen in the following table:

BRITISH COLUMBIA FACTORIES, 1952

Industry	Men (thousands)	Factory shipments
1. Sawmills	28	$316 million
2. Pulp	6	125 ,,
3. Fish curing	3	57 ,,
4. Slaughtering	1	54 ,,
5. Planing mills	3	48 ,,
6. Plywoods	4	42 ,,
7. Petroleum products	0·7	38 ,,
8. Foods	0·8	35 ,,
9. Fertilizers	1	32 ,,
10. Shipbuilding	4	30 ,,
11. Fruit	2	28 ,,
12. Bread	3	23 ,,

Some of these products greatly increased in value during the later years of the war, for instance shipbuilding advanced from sixth place in 1940 to second in the next year. Fish-packing is of course a typical product, and accounts for no less than 66 per cent of this industry in the whole Dominion.

Boeing Aircraft started in a small shipyard at Vancouver in 1916, but it was not till 1937 that orders from the R.C.A.F. helped the young industry.[1] Today (1944) the firm are shipping to Seattle various sections for bombers, and employ about 6,000 persons. Shipbuilding is being carried on at Vancouver, New Westminster, Victoria, and Prince Rupert, and gives employment to 35,000 persons. It is said that the largest cargo-shipbuilding organization in the Empire is sited at Burrard Inlet. Here during the war a force of 11,000 men has been at work. Plywood has been in great demand, and is exported in very large amounts in recent years. Paper cartons and airplane spruce are two other commodities based on the enormous timber resources of the province.[1]

[1] H. T. Mitchell, in *Industrial Canada* for January 1945, Toronto.

Canada's Trade with Foreign Lands

The basis of this section is an illuminating article in the *Year Book* for 1941, in which it is pointed out that Canada is far from being a self-sufficient country, and that the Dominion has a very special interest in the *international* division of labour.

Canada can and does produce large surpluses of many agricultural products (cereals, potatoes, apples, cattle, pork, and dairy products), of many forest products (pine and fir lumber, and spruce, poplar, and balsam pulpwood) of many mineral products (gold, silver, copper, nickel, lead, and zinc); and hydro-electric power more cheaply than can be done in most other countries.

On the other hand, Canada either cannot produce or is at a disadvantage in producing her own requirements of such essential raw materials as iron, coal, oil, rubber, and tin; of tropical fruits, fibres, and other natural products; and of many iron and steel, chemical and textile manufactures based on special local resources and techniques.

Canada is at once the world's largest exporter of wheat, newsprint, and non-ferrous metals, and one of the world's largest importers of coal, oil, and steel products.

It follows from a consideration of these facts that Canada suffers considerably more than most countries in a period of world depression, since she relies on the sale of her great surpluses in wheat, newsprint, &c. Her total of *imports* may change without such a marked effect on the general economy of the nation.

The following tables show the position occupied by the various countries in regard to imports from and exports to Canada:

TRADE WITH CANADA, 1953

(*million dollars*)

Countries supplying imports			Countries receiving Canada's exports		
Rank	Country	Value	Rank	Country	Value
1	United States	$3,221	1	United States	$2,419
2	United Kingdom	454	2	United Kingdom	665
3	Venezuela	155	3	Japan	119
4	West Germany	36	4	West Germany	84
5	Brazil	35	5	Belgium	70
6	Belgium	29	6	South Africa	51
7	India	27	7	Netherlands	42
8	Australia	23	8	Australia	40
9	Colombia	23	9	Brazil	38
10	Netherlands	22	10	Norway	37

In 1944 export of Canadian products reached the amazing and unprecedented total of over 3,000 million dollars. Although some

thirty-odd nations exceed Canada in population, none except the United States had a higher value of exports in that year. In peace time Canada is fourth among the exporting nations, so that this jump to second place is one result of the war. In the following table I quote some very interesting figures given by A. L. Neal in the *Canadian Geographical Journal* for March 1945. This table also emphasizes the great value added by the factory to primary products, and indicates the shift in exports due to the war. The last column is the most suggestive.

CANADA'S TOTAL DOMESTIC EXPORTS FOR 1939 AND 1943
(*in million dollars*)

	1939 (peace)		1943 (war)	
	Raw materials	Processed	Raw materials	Processed
Mineral origin	$51	$236	$45	$1,093
Mixed origin	—	33	—	640
Forest origin	20	223	25	366
Farm products	176	141	395	320
Marine origin	13	17	28	33
Total (with others)	274	651	519	2,971

An analysis of agricultural exports shows a very interesting shift, due directly to the war having cut off many of the normal supplies of Europe and elsewhere. These Canada has in part been able to export to such lands. The largest relative increases in export have been in beer and eggs, which have increased 50 and 30 times respectively from 1939 to 1943. United States had a shortage in cattle food, and imported ten times the normal amount of oats. Bacon, flour, canned meats, pork, and candy also increased about five times the normal. On the other hand hides, oatmeal, canned fruits, and apples were in very much less demand than in normal years.

In metals, of course, the export has been enormously increased. In the case of aluminium the export has risen from 6 millions to 129 million dollars. Tanks and motor vehicles have changed from 26 to 507 million dollars between 1939 and 1943. Guns have become a new industry, and the product amounted to 144 millions. Abrasives have been exported to double the value, but gold has declined greatly from 184 to 111 million dollars in 1944.

In the early years of the Dominion, the United Kingdom, which was then making extensive capital investments in Canada, supplied

more than one-half of Canada's imports. The United States, always a close second in Canada's import trade, supplanted the United Kingdom for first place in 1876, and has maintained that position almost every year since (A. L. Neal).

PRINCIPAL IMPORTS INTO CANADA FROM U.K. AND U.S.A. 1953
(values in million dollars)

From United Kingdom		From United States	
1. Wool	\$79·5	1. Machinery	\$541
2. Machinery	28	2. Automobiles	281
3. Automobiles	28	3. Electrical goods	172
4. Electrical goods	23	4. Chemicals	192
5. Gold, etc.	17	5. Petroleum	166
6. Cotton	16	6. Coal	147
7. Whisky	10	7. Cotton	111
8. Leather	8	8. Fruit	66
9. Coal	5	9. Books	63
10. Sugar	5	10. Paper	37

CANADIAN EXPORTS IN 1953 TO U.K. AND U.S.A.
(in million dollars)

United Kingdom		United States	
1. Wheat and flour	\$280	1. Newsprint	\$564
2. Iron products	127	2. Wheat and flour, &c.	151
3. Timber products	111	3. Nickel	108
4. Aluminium	65	4. Aluminium	91
5. Nickel	35	5. Fish	81
6. Copper	32	6. Copper	70
7. Silver, &c.	15	7. Farm machines	58
8. Tobacco	13	8. Whisky	53
9. Zinc	10	9. Asbestos	51
10. Asbestos	6	10. Zinc	45

CHAPTER XIX

COMMUNICATIONS

SOME of the vast changes in the methods of communication in the last three centuries in Canada have been discussed in various earlier chapters. But it is interesting to learn that it is today quite possible to experience some of the earliest types of travel, even in the eastern provinces of Quebec and Ontario. Members of the Geological Survey in the backblocks of both these provinces still travel in canoes, make portages, and are aided by the sole inhabitants, the local Indians, in much the same way as Radisson travelled through Ontario in 1659. It is true that the next phase of travel, by oxcart and York boat, has very nearly vanished; but there is plenty of primitive voyaging on the great lakes of the north-west for those who care for such things. The outstanding feature of much of pioneer Canadian life to this day is that the settlements have never been linked to the southern, closely populated, belt by *roads*. In many cases the railway is the sole link, in others the river. Of late years there are a few mining settlements where all supplies, &c., are brought in by air. Something of this sort was also the lot of folk living in the Liard and east Yukon areas, before the Alaska Highway supplemented the earlier airports.

We may rapidly summarize the history of major transportation in the Dominion. Mackenzie first traversed the continent by *canoe*, via Finlay Forks and the Peace River, in 1793. This was the method throughout the mountain parts of the west for nearly another century. The first *railway* crossed Canada in 1886 (p. 332); but the first transcontinental *road* was not completed until the two breaks at Big Bend (on the Fraser) and near Hearst (in the Clay Belt) were linked in 1939 and 1943 respectively. The first public *air* service from the east to the west was inaugurated in 1920. The dominance of canals occurred in the east about 1830; but then for many decades they were of relatively little importance, being overshadowed by the more convenient railways. These in turn have lost a good deal to the freight-truck and to the autobus, so that some of the eastern districts are marked by a number of abandoned railways. The importance of shipping, both on the lakes and rivers, as well as the coastal and trans-ocean traffic, must also be stressed in this chapter.

A. THE CANALS OF CANADA

In an interesting publication by the Department of Railways

(Ottawa, 1934) entitled the *Canals of Canada*, the whole subject of this section is reviewed; and some of the salient features are given in the following table.

CANALS OF CANADA

Name	Location	Length (miles)	Locks	Depth in ft.	Open*	Closed by ice*
Lachine	Near Montreal	9	5	14	Apr. 20	Dec. 10
Soulanges	" "	15	5	15	"	"
Cornwall	" "	11	6	14	"	"
Farran's Point	" "	1	1	16	"	"
Rapide	" "	4	2	14	"	"
Galops	" "	7	3	14	"	"
Welland Ship	Niagara	28	8	25	"	Dec. 15
Sault St. Marie	E. of Superior	1	1	18	Apr. 18	Dec. 14
Carillon	Ottawa R.	1	2	9	Apr. 27	Nov. 30
Grenville	"	6	5	10	"	"
Rideau	Kingston	126	47	5	May 1	"
Chambly	Richelieu R.	12	9	6	"	"
Murray	Trenton	5	0	11	Apr. 22	Dec. 2
Trent	L. Simcoe	281	44	4–6	Varies	Varies
St. Peter's	C. Breton	1	1	18	Apr. 10	Jan. 10

* Approximate dates.

The Great Lakes Route

From Montreal to Fort William at the west end of Lake Superior is a distance of 1,215 miles, which can be traversed by any boat not drawing more than 14 feet. As a matter of fact, the cargoes on this route via the Soo and Welland Canals, exceed in tonnage those passing through the Suez or Panama Canals. The Canadian 'inland passage' may well be measured from Belle Isle north of Newfoundland, when the total distance of this approach to the heart of a continent amounts to 2,218 miles. As regards length of travel it is only exceeded by the Amazon, in which boats drawing 14 feet can travel 2,786 miles from the ocean, as far as Achual Point some 486 miles above Iquitos. There is of course no comparison in the relative importance of the two hinterlands affected. It is worth noting that since 1900 the Chicago–Illinois Canal was made available for barges drawing 24 feet, so that now Canadian vessels can connect with the extensive Mississippi system of waterways.

The relative amounts of traffic on the various canals can be judged from the following table, giving the total tonnage for the year 1942. (If a vessel uses two or more canals in its journey, the cargo is repeated in each case.)

CANAL TRAFFIC ON CANADIAN WATERWAYS IN 1942

(*in million tons*)

1. Welland Ship Canal	11	4. Ottawa River	0·3
2. St. Lawrence River	6	5. St. Peter's	0·2
3. Sault St. Marie	3	6. Richelieu R.	—

It is to be remembered that the *American* Canals at Sault St. Marie carry about 115 million tons of cargo in the year, as contrasted with the much smaller traffic on the Canadian canals. The dominant traffic, from a tonnage aspect, is iron ore, which reached a total of 94 million tons in 1942. However, the value of the wheat passing through the canal has usually been higher than that of the iron ore, while bituminous coal has generally been second in tonnage to iron ore, and a large part of it is carried by the ore vessels when returning west for a cargo of ore. (See Fig. 143.)

The position of the main canals on the St. Lawrence River between Kingston and Montreal is given in Fig. 145. In this

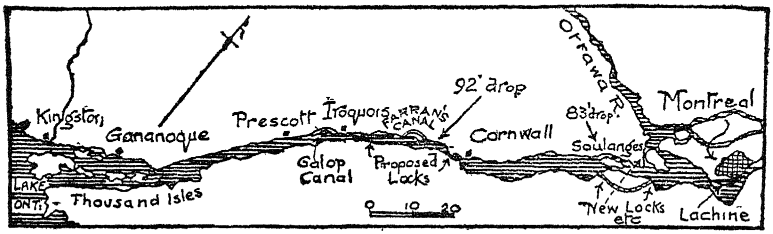


FIG. 145.—The canals constructed or proposed along the St. Lawrence between Lake Ontario and Montreal. Here the river drops 220 feet in 100 miles

distance of 100 miles the big river descends 220 feet in six rapids, which have been paralleled by the canals given in the foregoing table. Most of these are charted in Fig. 145. Small passenger steamers 'run' several of these rapids, but barges use the canals. In recent years a Joint Commission appointed by U.S.A. and Canada has been devising a plan to improve the navigation of the St. Lawrence. They propose to cut channels which will enable boats of 25 feet draught to enter Lake Ontario, in place of the present canals, which only allow boats of 14 feet draught to reach Lake Ontario. (See diagram, p. 487.)

A tremendous development of hydro-electric power is possible, and this is stated to amount to 5 million horse-power. Locks and canals on each side of Farran's Canal are suggested, as well as a special channel lower down the river opposite Soulanges (Fig. 145). The cost of a 25-foot channel together with the development of a million

and a half of horse-power is stated to be around 253 million dollars. This ambitious project is in abeyance, until world conditions are more settled. (Work commenced in 1954.)

The Niagara Escarpment and its Canals

There are three canals crossing the Niagara Peninsula from the upper Lake Erie (at 572 feet above sea level) to the lower Lake Ontario, which is 245 feet above sea level. The topography of this interesting region is charted in the block diagram given in Fig. 146,

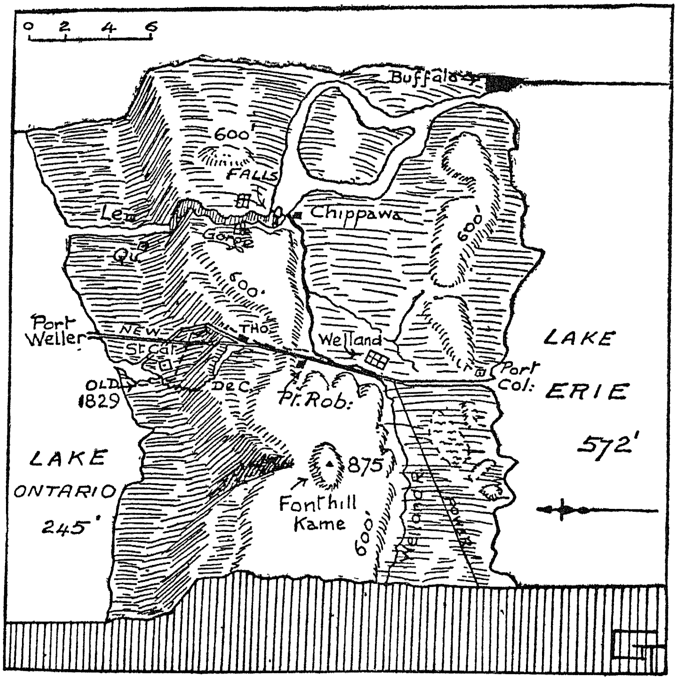


FIG. 146.—The portages and canals at Niagara Falls—looking east. The first Canal (1829) was extended to Port Colborne in 1833. The new Ship Canal reached Port Weller in 1932

where the view is to the east, since the Niagara River flows almost due north. The narrowest and lowest portion of the peninsula is not that chosen by the glacial waters to spill over the Niagara Falls. Hence the canals all reach the lower lake in the vicinity of St. Catherine's rather than to the east near Queenston (QU. in Fig. 146).

The original canal and locks enabled small boats to climb the scarp and to enter the Welland River at Port Robinson and so reach Chippawa. It was completed in 1829, and passed through Thorold

and south-west of St. Catherine's. In 1833 what was essentially a new canal was constructed, which started from Lake Erie at Port Colborne, joined the old canal near Welland, passed through Thorold over the scarp, but was diverted to the northern side of St. Catherine's as shown in Fig. 146. By 1845 this canal was deepened to take boats of 9 feet draught. There was of course a good deal of excavating necessary, especially about 2 miles north of Port Robinson, where some 45 feet of stiff clay was removed in cutting the canal. The level of the water in the latter was raised by a 'feeder' from Grand River, some 17 miles away. Here the river was dammed, and a canal led the waters into the main channel near Port Robinson. From Thorold the old canal descended 306 feet in the next 6 miles. In 1883 this canal was deepened to 12 feet in depth, and again in 1887 to 14 feet.

In 1913 the Welland Ship Canal was commenced, and this has superseded the earlier canals. Leaving Lake Ontario at Port Weller (which is 3 miles east of the former outlet at Port Dalhousie), it follows an entirely different route from the former Welland Canal as far as Thorold. From this point to the Lake Erie entrance at Port Colborne the new route adheres in general to that of the old canal (Fig. 146). This Ship Canal is 27·6 miles long, and contains 8 locks, each about 860 feet long by 80 feet wide. The total rise is about 327 feet, and the canal is designed to be able ultimately to take boats with 30 feet draught.[1] Until the projected St. Lawrence Waterway is completed above Montreal, none of these deep-draught boats can move east from Lake Ontario and reach the ocean.

From Port Colborne to Sault St. Marie is 575 miles, and here are several canals, the largest being on the American side of the rapids. The Canadian canal was built between 1887 and 1895, and is 1·38 miles long. There is one lock, 900 feet long and 60 feet wide. This lifts the boats about 19 feet, and raises them to the level of Lake Superior (Fig. 143).

The Rideau and Trent Canals

The traffic on these two canals is so insignificant that not much space can be given to their description. The Rideau Canal only carried a total of 1,700 tons in 1942, and is used primarily for pleasure boats and to give power to ancient grist-mills along its banks. It was built between 1826 and 1832, when the enmity of the United States was a possibility to be feared; and afforded a safe voyage from Montreal to Ottawa, and thence by the canal to Kingston on Lake Ontario. A boat rises by eight locks from the river at Ottawa City, and soon enters the Rideau River. After 60 miles it reaches

[1] See the lengthy description by P. J. Cowan published by *Engineering*, London, in 1935.

Smith's Falls, and then passes into Rideau Lake, where it is 275 feet above Ottawa River. After traversing a number of small lakes, it reaches the waters of the Cataraqui River. This river is followed for 6 miles and leads directly to Kingston on Lake Ontario. The canal takes boats of 5 feet draught only (Fig. 52).

The Trent Canal has had a very varied history; and the name is given to a series of navigable rivers and lakes which are connected by short canals to form a continuous waterway for about 224 miles, from the Bay of Quinté near Trenton to Port Severn in Georgian

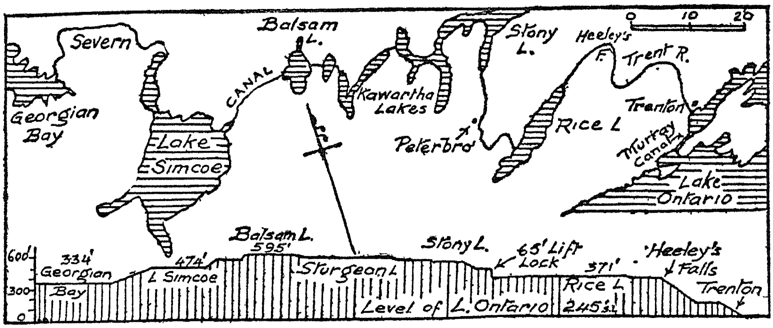


FIG. 147.—Map of the Trent Canal system, linking Lake Huron to Lake Ontario by the Severn and Trent Rivers. Below is a vertical section along the Waterway showing the levels of the smaller lakes above Lake Ontario

Bay (Fig. 147). The rise from Lake Ontario to the summit level at Balsam Lake is 595 feet, and is overcome by 35 locks. Then there is a drop of 260 feet to Georgian Bay, which is negotiated by eight locks and two 'marine railways'. The latter carry small boats overland for short distances along the Severn River. Some 28,000 tons of mineral products were carried by this canal in 1942. The most interesting feature of the canal is the Hydraulic Lift Lock at Peterborough, which was built between 1901 and 1904, and cost $224,000. It works on the principle of a balance, one giant iron 'box' rising and carrying the boat, while a similar 'box' is descending. Each lock chamber (or box) is 139 feet by 33 feet, and this is raised through 65 feet by the lift.

B. CANADIAN SHIPPING—INLAND AND OCEAN

Before describing the main shipping routes some attention may be given to the chief harbours of the Dominion, though much of the data of interest in recent years is reserved from publication owing to the war. In the following table information regarding five of the chief ports for the year 1943 will be found; and in the second table data concerning other ports.

CANADA'S FIVE PRINCIPAL HARBOURS

	Vancouver	Montreal	Quebec	St. John	Halifax
Approach channel	35 ft. deep	32	35	30	50
No. of piers	28	105	36	20	46
Grain elevators	18·7 mil. bu.	15	4	3	2·2
Coal dock (capacity)	—	1·3 mil. tons	0·2	34,000	115,000 tons

CHIEF PORTS, WITH SEA-GOING VESSELS CLEARED FOR 1953

(*tons register*)

1. Vancouver	21 million tons	6. Port Arthur	5 million tons
2. Victoria	10 ,, ,,	7. Fort William	4 ,, ,,
3. Montreal	10 ,, ,,	8. Sarnia	4 ,, ,,
4. Halifax	5 ,, ,,	9. Toronto	3 ,, ,,
5. Quebec	5 ,, ,,	10. Hamilton	3 ,, ,,

Canadian shipping attained some prominence in the days of the fast sailing vessels, and also at a later date when steam-power first came into use. In 1833 the *Royal William*, a Canadian ship built to ply between Quebec and Halifax, crossed the Atlantic from Pictou to London, and was the first vessel to navigate the Atlantic entirely under steam-power. At the present time, in addition to other lines, the Canadian Pacific Railway operates fleets on the Atlantic and Pacific Oceans, and the Dominion Government operates a fleet in the West Indies trade (*Year Book*).

The growth in the shipping is illustrated by the following table for the years 1930 and 1940:

NUMBER OF SHIPS AT CANADIAN PORTS

	British	Canadian	Foreign
1930	5,634	18,145	19,689
1940	10,782	32,595	19,227

The inland shipping is of course of great importance on the Great Lakes. It consists mainly of large steel bulk-freighters, which in 1931 accounted for 85 per cent of the total gross tonnage. One of the largest of these vessels is the *Lemoyne*—a freighter used to carry grain, coal, or ore—and this huge vessel has a length of 633 feet, beam of 70 feet, and 25 hatches. In recent years there is a strong tendency to amalgamate shipping lines, so that in 1936 the 'Canada Steamship Lines' operated 101 vessels, ranging from 2,000 to 7,000 tons.[1]

[1] *History of Transportation in Canada*, by G. P. T. Glazebrook, Toronto, 1938.

Air travel in the north-west, &c., has by no means done away with the small steamers which were placed on the rivers many decades ago. For instance, the Hudson's Bay Company maintains a fleet of a dozen steamers on the Mackenzie and its tributaries, such as the Liard and Peace, which are a vital factor in the life of that part of the Dominion. Between Toronto and the Saguenay River several flourishing companies maintain regular services through the summer months, which are used not only by commercial travellers along this waterway, but are very popular with tourists. For their benefit huge tourist hotels are supplied at Quebec, Murray Bay, Tadoussac, &c.

Shipping on the Great Lakes

This important phase in Canadian industry may be said to have begun when La Salle launched four ten-ton schooners at Kingston in 1678. Next year he placed the *Griffon* on Lake Erie near Buffalo, and sailed it to the south end of Lake Michigan. This vessel was soon wrecked, and nothing larger than a canoe seemed to have been placed on the upper lakes for a century. In 1755 the British launched several boats from Oswego on the south-east corner of Lake Ontario; while in 1763 several schooners were also built above the Niagara Falls by the British.

The varying growth of these old French ports on the lakes has been studied by L. J. Burpee (*Canad. Geog. Jnl.*, 1939), who points out that Chicago, which was unknown to the French, has now over 3 million people—mainly owing to its unique geographical position at the 'corner' of Lake Michigan, to the portage to the Mississippi, and later to the railways converging here. Mackinac—once the chief centre on the lake—has now, after 270 years, only about a thousand people. 'Fort Niagara, with a history that goes back 261 years, is now a silent relic of the past.' Detroit has grown rapidly, and now has 2 million inhabitants, while once equally important Oswego and Kingston have only reached a figure of 24,000; and Toronto, which contained about 20 people in the French regime, now holds nearly a million. Fort William was the chief port early in the 19th century for the fur-traders, but was eclipsed (around 1884) by Port Arthur, though it is again the leader now.

Steam navigation on the Great Lakes began with the launching of the *Frontenac* at Kingston in 1816. In 1818 a steamer *Walk-in-the-Water* was launched at Buffalo, but steamers did not reach Lake Superior until 1845 by way of the Soo portage. (The first ship canal was built on the American side in 1855.) By 1900 only a few sailing ships were left on the Great Lakes.

Today there are lines of passenger steamers plying between such ports as Buffalo and Detroit, Toronto and Montreal, Detroit and

Duluth, Sarnia and Fort William, Port McNicoll and Port Arthur, Chicago and Milwaukee. The Canada Steamship Line operates the largest fleet, totalling over 100 passenger and freight vessels. Among the latter are the ore-carrying barges which have already been described. The Ford Motor Company operates two motor ships each of 8,000 tonnage. It may be added that some of the largest steamers are 550 feet long, and can carry 1,200 passengers. It is worth noting that the character of the traffic on the Great Lakes is largely controlled by the shallow depth (14 feet) of the St. Lawrence canals. Here is the chief argument for the projected St. Lawrence Waterway.

Canadian Pacific Steamer Lines

On July 26th 1886 a brig from Yokohama arrived at Port Moody (B.C.), and her cargo was transferred to the newly completed Canadian Pacific Railway for transfer across the continent. In 1887 the company started a regular steamship service to Yokohama and Hong Kong; and in 1891 the first of the famous 'Empress' boats commenced to sail on this route. It was not till 1903 that the company officers extended their operations to the Atlantic, but in that year they bought 15 steamships from the Elder Dempster Company, and in 1915 they absorbed the Allan Line. In 1937 the company had 14 steamers in the Atlantic Service, ranging down from the *Empress of Britain*, which is 42,348 tons, to the five 'Beaver' boats each around 10,000 tons. In the Pacific there are four 'Empress' boats, the largest being the *Empress of Japan* with a tonnage of 26,000. The company maintains 331 officers in connexion with these steamers, and employs about 8,000 men in maintaining their steamship services.[1]

The great company also maintains a number of inland steamer services, such as those on the Great Lakes, which started in 1884. Two 3,000-ton steamers were built in Scotland; and these were cut into sections when they arrived at Montreal, so that they could be towed through the small locks on the St. Lawrence canals. They were joined again at Buffalo; and for many years have been plying on the route from Port McNicoll (on Georgian Bay) to Fort William. Five of these boats were operating in 1937.

Another important line connects St. John with Digby across the Bay of Fundy. At the latter place passengers from Montreal are transferred to the railway and carried to the ocean docks at Halifax. Two of these steamers, each of about 4,000 tons burden, maintain this interesting link in the transcontinental line. There are also ten ships on the lakes and rivers of British Columbia. This service started on Arrow Lake in 1896, and similar ships were later in use

[1] *Canadian Pacific Facts and Figures*, Montreal, 1937.

on Slocan, Kootenay, and Okanagan Lakes. Many of these services have been replaced by later railways. Three 'Princess' ships of about 6,000 tons burden ply along the Pacific coast from Vancouver to Alaska, while others link Vancouver to Seattle.

C. CANADIAN HIGHWAYS

Until the advent of railways, roads and canals were of much greater relative importance than they became later on. The early roads have been discussed briefly in regard to the spread of settlement (pp. 307–37), and as stated, they were often cut through the forest before any settlement occurred. This early trail usually became the base-line for the local surveyors, and the townships were laid out along the roads. Hence the road had an added interest because it was of prime importance in subdividing the lands, as well as in opening them up.

The chief roads in eastern Canada about 1830 are shown in Fig. 148 which is based on a number of maps in Burpee's *Historical Atlas* —a book no student of Canadian geography should be without.

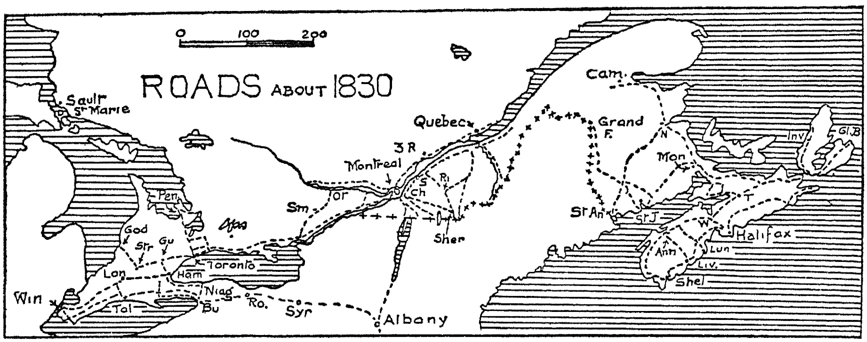


FIG. 148.—The chief early roads of Canada. (Based partly on L. J. Burpee's *Historical Atlas*)

There were three rather widely separated road-nets at this time, as the map shows. In the east, Nova Scotia and southern New Brunswick were well served by roads as early as 1830. There was a great break however between this part of Canada and the region to the south-west of Quebec City, where again there was a good road-net linking Sherbrooke to Montreal and Quebec. In Ontario the chief early settlements tended to lie to the west of Toronto, and to some extent spread out from Niagara—which indeed for a short time was the local capital. Thus there was a road-net surrounding London, in part due to the energy of Colonel Talbot (p. 316).

Glazebrook in his study of Transportation (*loc. cit.*) points out

that the roads were of pioneer class until about 1900. The earliest roads were of the corduroy type, consisting of logs laid across the road with earth thrown between. It was not till 1839 that the roads began to be macadamized, one of the first being that between Kingston and Napanee. Yonge Street, the famous route leading north from Toronto, was also macadamized in part about this time. About the same time many roads were made of wooden planks, which for a time served the traffic fairly well, but soon wore out. Many Turnpike Trusts were instituted in which local folk built the road, and were empowered to collect tolls at the turnpike in reimbursement. Of course there were rough trails before fair roads were made, as for instance that connecting the Maritimes with Quebec by means of Lake Temiscouata as early as 1825. It was not till the 'forties that travel by road became at all easy in this portion of Canada.

In 1855 the roads of Ontario included a lake shore road from the Ottawa River to Niagara which acted as a trunk-line. Yonge Street ran to Holland Landing and then round Lake Simcoe to Penetanguishene (Fig. 147). The last part of this was 'very bad' in 1855.

From Owen Sound (then called Sydenham) there was a main road to Toronto, and the famous Garafraxa Road led south to Guelph. The Kawartha Lakes had a number of roads, but the region of the Shield to the north was described as 'bad land—no settlers'. Simcoe Street went from Oshawa to Beaverton on Lake Simcoe. As early as 1800 there was a public mail-stage from Quebec to St. John, but this, one presumes, went through U.S.A. In 1817 a stage-coach connected Montreal with York (Toronto), and by 1836 there was a daily service between Toronto and Hamilton.

Turning to modern times, a reference to Fig. 65 will be helpful to enable the reader to gain a knowledge of the state of the main roads on the borders of close settlement. In this map of British Columbia all the roads on the margins of settlement are mapped, and it is obvious that Hazelton is the 'farthest north' at the date of the map (1941). No road was yet available to Finlay Forks, though a rough trail led thereto. No road connected Hazelton with the coast, though the Canadian National Railway had been in operation for some thirty years. No road crossed the Rockies north of Kicking Horse Pass, though a remarkable 'scenic road' had just been completed from Banff north to Jasper on the east side of the divide. Two roads (beside that at Kicking Horse) crossed the Southern Rockies, at Vermilion and Crow's Nest Passes. From Crow's Nest to Vancouver a road had recently been completed just along the border, though it was necessary to journey far north to Spencer's Bridge to connect with the road along the Fraser canyons.

The alternative route via the Big Bend on the Columbia River had just been completed. No roads reached the coast from the interior anywhere except at the Fraser Delta in the far south.

In the earlier chapter some description of the Alaska Highway has been given (p. 281). This 1,630 mile roadway links Dawson Creek with Fairbanks in Alaska. It was virgin territory, and a pioneer air route, in the spring of 1942, but by 20th November in the same year it was officially opened for wheel traffic. About 10,000 United States engineer troops and 4,000 civilians, of whom half were Canadian, hewed their way through the bush, bridged the rivers, overcame mountain grades, and surfaced a roadbed before the year was out (*Year Book*). U.S.A. maintained the highway for six months after the war was over and then the equipment and road reverted to Canada.

In the table on page 476, the various classes of highways in the several provinces are enumerated. Urban streets are not included in the figures, which refer to the year 1942. (Trucks, cars, and buses are added.)

Today, the Trans-Canada Highway between Vancouver and Tadoussac (Q.) has just been made available to travellers, when the highway was cut through the forests of the Shield between Long Lake and Hearst to the north of Lake Superior. The difficult ranges of the Rockies were crossed by roads many decades earlier, but the needs of the residents in the vicinity of Hearst were met by the four railways, which crossed this portion of the Shield before a single through-highway was built.

D. THE TOURIST TRAFFIC IN THE DOMINION

The value of Canada's tourist traffic reached its high point in 1929, when the estimated expenditures of her foreign visitors amounted to approximately 309 million dollars.[1] With the shrinking incomes and other features of the depression which ensued, there were successive declines to the low point in 1933, when the expenditure was only 117 million dollars. However, by 1939 this outlay had risen again to 275 million dollars, of which 262 million dollars represented expenditure by visitors from the United States.

Baron Tweedsmuir was a great admirer of Canada's beauty spots, as the following quotation (given by Mr. Neal) will show:

> It offers every variety of landscape—the rockbound coast and the strong salty tides of Nova Scotia; the red cliffs and shining sands of Prince Edward Island; the great woods of New Brunswick; the forested hills and innumerable lakes of Quebec; the St. Lawrence waterway, the noblest approach to any country. Then there is Ontario, home of

[1] From an article by A. L. Neal in the *Canadian Geographical Journal.*

ROADS, RAILROADS, AND VEHICLES IN THE NINE PROVINCES—1942

Class	P.E.I.	N.S.	N.B.	Quebec	Ontario	Man.	Sask.	Alberta	B.C.	Total
Cement	4	7	—	305	2,108	31	—	—	41	2,496
Bitumen	202	925	959	3,700	5,000	510	146	680	1,540	9,069
Gravel	242	5,490	7,603	18,000	52,000	8,300	6,100	4,000	7,500	106,400
Earth	3,258	8,641	3,733	18,535	16,701	82,484	206,669	89,233	12,595	441,849
Totals	3,706	15,063	12,295	40,555	73,001	91,328	212,968	93,896	21,726	564,538
Trucks	1,221	15,060	9,575	45,609	95,861	20,600	39,310	31,297	28,615	287,000
Cars	6,268	42,844	27,623	173,036	611,897	71,673	89,742	93,103	100,582	1,216,000
Buses	15	165	176	1,127	1,518	108	246	192	469	4,016
Railway Mileage	286	1,396	1,836	4,797	10,480	4,837	8,780	5,681	3,849	42,339

Railroad mileage in 1952 was 42,953.

many industries and high farming, the Great Lakes, and then after a thousand miles of prairie, the wall of the Rockies, and the mountain valleys, fiords and islands of British Columbia. And last—only now being opened up—there is the huge north, with mile-wide rivers and lakes the size of states, and natural wealth to be won up to the very edge of the Polar ice.

The most interesting portions of the Dominion are being reserved as National Parks, either by the Ottawa authorities or by the Provincial Governments. The following table shows the twenty National Parks, which have a total area of 12,525 square miles (Fig. 149):

NATIONAL PARKS

Park	Province	Area (sq. miles)	Features
Cape Breton Highlands	N.S.	458	Rugged coastline and mountains
Fort Anne	,,		Early Acadian settlement, at Annapolis
Prince Edward Island	P.E.I.	8	Twenty-five miles of beaches, on north coast
St. Lawrence Islands	Ont.	(186 acres)	Thirteen of the 1,000 islands
Georgian Bay	,,	5	Thirty islands with caves
Pt. Pelee	,,	6	Beaches, flora, and birds
Riding Mt.	Man.	1,148	Woodland lakes and game
Prince Albert	Sask.	1,869	Forest, lakes, and fauna
Elk Island	Alta.	51	Buffalo, moose, deer, and wapiti near Edmonton
Buffalo	,,	197	5,000 buffalo, near Wainwright
Nemiskam	,,	8	Park for 325 prong-horned antelope, near Medicine Hat
Wawaskey	,,	54	New park for antelope
Waterton Lakes	,,	220	On U.S. boundary, glacial valleys
Banff	,,	2,585	Mountains, glaciers, hot springs
Jasper	,,	4,200	Majestic peaks, lakes, and big game
Yoho	B.C.	507	Near Kicking Horse, waterfalls
Glacier	,,	521	Selkirk Mountain peaks
Mt. Revelstoke	,,	100	Alpine plateau near Selkirks
Kootenay	,,	587	Mountains and canyons, head of R. Kootenay

Many of the most important tourist resorts are not mentioned in the foregoing table. For instance, in the province of Quebec ski-ing is the most popular winter pastime, and many resorts have sprung up in the plateau of the Shield where this sport is indulged in. Lac Beauport, 9 miles north of Quebec City, is one such meeting-place; but there are many others in the vicinity, such as Valcartier, Charlevoix, la Beauce, and Grandes-Piles (near Three Rivers).

In the Eastern Townships are Abercorn, Sutton, Mount Orford, and Waterloo, where hundreds of skiers are to be found during the long Canadian winter. The Gatineau valley to the north of Ottawa is becoming increasingly popular, but the most famous region of all is about 80 miles to the north-west of Montreal in the Laurentians. In the 18-week season 400 special 'ski trains' are run, carrying 145,000 passengers, and involving an expediture of about a million dollars in this 'industry'. In the vicinity of Mont Tremblant, 'the highest Canadian mountain east of the Rockies', are 40 miles of ski-trails. Val Morin, St. Adele, Mt. Rolland, and Morin Heights are also ski centres in this snowbound plateau country (Plate I).

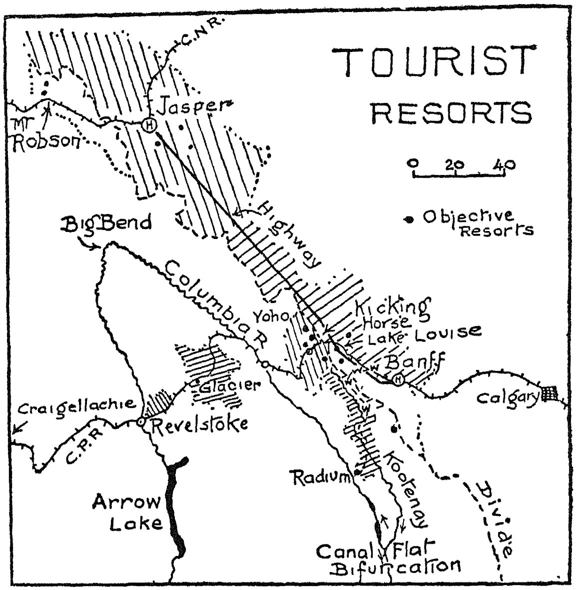


FIG. 149.—The chief tourist resorts in the Canadian Rockies, showing six National Parks. 'H' and 'W' refer to Headquarters and Wayside Resorts. (Based on S. B. Jones)

Ontario has its skiers, but the sport is not so popular as in Quebec, since the snowfall is less and the elevations lower. The summer resorts in the famous Muskoka Lakes attract their thousands for the bathing and fishing. This region lies about 100 miles north of Toronto, and tourism is one of the chief resources of folk living on the poor soils of the Pre-Cambrian Shield. Small steamers cruise through the three linked lakes (40 miles long) which are grouped as the Muskoka Lakes (Fig. 53).

The Rocky Mountains of course offer the finest touring region of all, with the most popular centres at Banff, Lake Louise, and Jasper. We owe to S. B. Jones a critical study [1] of the resorts in this area, which he divides into Headquarters, Objective, and Wayside types. The first, such as Banff or Jasper, serve as residence centres, outfitting points, and trade foci for recreational regions. *Objective* resorts such as Lake Louise are visited for particular views, and usually for shorter periods. *Wayside* resorts (i.e. near Banff) exist primarily to supply food and lodging to passing motorists. In Fig. 149 these three types are indicated by ' H ', a black dot, and ' W ' respectively. The National Parks in this region are also charted, together with the Big Bend, where the transcontinental road was completed, the bifurcation of the Kootenay River at Canal Flat, and Craigellachie where the sections of the Canadian Pacific Railway were linked in 1885.

The famous Banff–Jasper Highway, which was completed in 1940, is one of the most beautiful scenic routes in the world. The road leaves Banff at 4,500 feet above sea level, and in 37 miles reaches Lake Louise (Fig. 149). Near this point it leaves Kicking Horse Pass on the west, and soon crosses Bow Pass (6,878 ft.) at the head of Bow River. Farther north at Sunwapta Pass (6,675 ft.) we leave Banff Park and enter Jasper Park. Many peaks over 10,000 feet flank the Highway, including Mt. Athabaska, which is 11,542 feet above sea level. Here the road approaches within a few hundred feet of the Athabaska Glacier, and nearby is the Columbia Icefield which covers 150 square miles. Still farther north are the Athabaska Falls. After a journey of 186 miles the tourist reaches Jasper on the Canadian National Railway—another Headquarters centre.

E. THE RAILWAYS OF CANADA

A description of some of the earlier railways of the Dominion will be found in the chapter dealing with the spread of settlement. In Fig. 150 most of the railways constructed by 1860 are charted, and the history of the first railways is summarized in that section. The next stage in their development can be gathered from the map given in Fig. 150, where all the railways as shown in the chart by G. A. Tackabury (as given in his Atlas, Montreal, 1875) are inserted. At this date there was already a fairly complete rail-net south of Montreal and another west of Port Hope, including Toronto, London, and Windsor. It was possible to journey from Halifax to Dalhousie, and up the Matapedia, to Mont Joli, Rivière du Loup, and Quebec. From here there was a railway to Windsor, where the American lines could be reached at Detroit to link with Chicago and St. Paul;

[1] *Recreational Regions of the Rockies*, Geog. Soc., Philadelphia, 1936.

and after 1878 with Pembina and Winnipeg (Fig. 151). In the early days of prairie settlement this was how many of the Canadians from Ontario reached the new lands of Manitoba.

The great period of Transcontinental railways occurred from about 1875 to 1915, for during this span of forty years three independent lines crossed the Dominion. No project in the history of our Empire is of greater interest than this first crossing of a continent by a British railway. (The Union Pacific had reached San Francisco in 1869, and was followed by the Southern Pacific in 1883; both being completed before the Canadian Pacific reached the western ocean in 1885.)

One of the clauses in the Act of Federation in 1867 agreed to the building of a railway to link all the provinces. This was to be started within a year, and the first stage was the construction of the

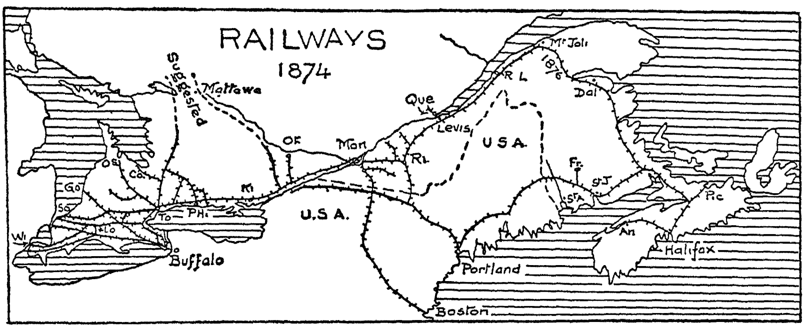


FIG. 150.—The chief railways of Canada about 1874, based on a map in Tackabury's *Atlas*. The Intercolonial Railway from Halifax to Levis was not completed till 1876

line from Halifax to Quebec just described. This took a rather lengthy route *via* Mont Joli (Fig. 151), because of recent friction with the United States; otherwise a route through Maine (later used by the Canadian Pacific) might have been employed. This Intercolonial Line as it was called was completed in 1876, and today is incorporated with the Canadian National Railways.

Building the Canadian Pacific Railway

Surveys for the great transcontinental line began in 1871, and were under the direction of a Canadian engineer, Sandford Fleming. The region north of Lake Superior was almost wholly unknown at this time, but he chose a route south of Lake Nipigon in 1873, which was much that actually followed later by the railway (Fig. 151). He

planned to cross the Red River at Selkirk, but later it was decided to turn south and build the bridge at Winnipeg, though here the river was wider. Across the prairies Fleming planned to reach the Rockies not far from Edmonton, for he wished to cross the better-watered portion of these rich agricultural lands. His plan was not adopted, for a southern route was chosen later; but the northern route is much that followed by the Grand Trunk Pacific (now C.N.R.), and subsequent settlement has shown that Fleming's original plan was a wise one.

In British Columbia the difficulties were extreme, as the discussion of the topography of that province (pp. 167–75) will have indicated. By 1877 no less than ten possible routes were being debated. There was a strong party in the west who wished the terminal to be at Victoria on Vancouver Island. This would necessitate a very

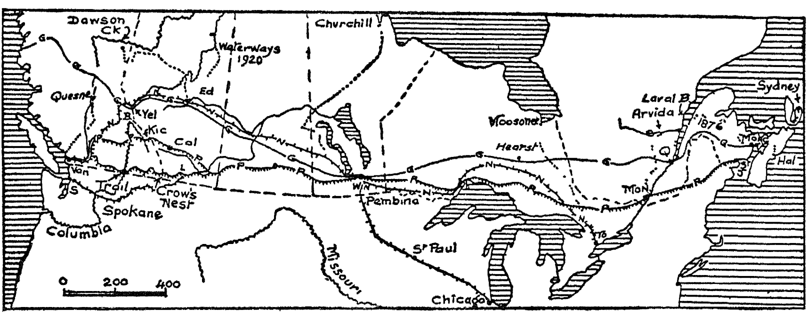


FIG. 151.—The Transcontinental Railways across Canada. P–P is the Canadian Pacific; G–G is the old Grand Trunk; and N–N is the old Canadian Northern. The main northern branches of recent date are shown by dotted lines

expensive bridge across the narrow straits, and finally this aspect of the plan was abandoned. Alternative routes to reach the coast by the Skeena River were surveyed, and these also were of use to later railways.

The huge railway was built in sections, some having little direct connexion with the main line. Thus a railway from Pembina reached Winnipeg in 1878, though the first locomotive was brought down the Red River on barges in 1877. By 1880 the following sections were nearly completed:—Fort William to Selkirk (Winnipeg); west of the Red River for 100 miles; and about 127 miles in the middle Fraser valley in British Columbia (Glazebrook, *op. cit.*).

A new construction company, largely directed from Montreal, was given charge of the line in 1880. This company agreed to build the line on a land-subsidy basis, i.e. they were to be given 25 million

acres of land as well as 25 million dollars in bonds. The land was to be granted as alternate sections of 640 acres each, 24 miles deep on either side of the railway between Winnipeg and the Rockies. No railways were to be built *south* of the transcontinental (which might lead traffic away to the American lines) for twenty-five years. By 1882 the various sections east of Winnipeg were completed. In 1882 5,000 men were at work on the prairie section, and by June 1883 the summit of the divide at Kicking Horse Pass was reached (Fig. 64).

It is of considerable geographical interest to examine why this Pass was chosen rather than the Yellowhead farther north. The latter is much lower (3,711 feet as opposed to 5,339 feet), but the company was looking to advantages from American traffic later on. It is stated that some of the directors feared that a northern railway would interfere with the fur-trade of the north. A practical objection to the north lands at this time was that there were no wheats which were suited to cold conditions at that date, though a number have been developed since (p. 403). Finally, the southern route was distinctly shorter for a railway between Winnipeg and Vancouver (Fig. 151).

It was not until the summer of 1882 that a practicable route over the rugged Selkirks was discovered at Rogers Pass. This cut across the 'Big Bend' of the Columbia River, but meant very heavy grades. (These have since been improved by the 5-mile tunnel under Rogers Pass.) The tunnels, cuttings, and bridges necessary to carry the line down the Fraser canyons make this portion of the line one of the most scenic in the world, as well as one of the most costly to build. Finally, Port Moody on Burrard Inlet was linked with the Kicking Horse section of the railway on November 7th, 1885, at Craigellachie, not far from Revelstoke. Later it was decided to have the terminal point of the great railway nearer the ocean at Coal Harbour (Vancouver). The railway reached the newborn town of Vancouver in 1886.

Brief mention may be made of another long Canadian Pacific railway in British Columbia, which was completed about thirty years later. This brings the coal of Crow's Nest and Fernie and the ore from Kimberley to the great smelters at Trail. It also carries the fruit and other agricultural products of Okanagan and the vicinity over the mountain ranges to Vancouver (Fig. 65). It seems to the writer to be as scenic as the better-known line to the north through Kamloops; and a number of particulars of this interesting 'Kettle Valley' Railway will be found on p. 183.

The Two Later Transcontinental Railways

To the dispassionate geographer viewing the meagre resources

of the great Shield today, there would seem to be not much reason for four long railway lines traversing the region north of Huron and eastern Superior. To understand this it is necessary to realize the spirit of optimism which followed the opening of the prairies at the close of the last century. As Glazebrook writes in his study of Transportation (Toronto, 1938):

> There was a rooted belief throughout the country that it was only a question of time before Canada would grow in population and wealth as she had done in territory. That belief seemed to be justified when the new century brought a flow of immigrants, capital, and orders for foodstuffs. Since the land of the American west was nearly taken up, the tide of European emigration must be diverted to Canada, which would then go through a similar stage of rapid development. Out of such comforting thoughts rose the expression, 'Canada's century'. It was in this atmosphere of optimism, and with tangible signs of better days, that the third great movement of Canadian railways was imagined and begun. . . . The prime motives in building the two later transcontinental railways were to provide more adequate transportation facilities for the west, and—on the part of the companies concerned—to share in the traffic that was being created there.

In 1900 the Canadian Pacific Railway had built a few branches from their great artery to tap Saskatoon, Prince Albert, and Edmonton; while farther west were others to Macleod and Lethbridge. But there was another line—the *Great Northern*—which had a number of railways in the plains south of Winnipeg; while in the east the *Grand Trunk*, with outlets at Chicago and Portland (Maine), had a number of lines which it hoped in time to weld into a transcontinental system (Fig. 106).

The Grand Trunk began the construction of the Moncton to Quebec line in 1905, passing through Edmundston and Rivière du Loup (as shown by the line labelled G—G in Fig. 151). This duplicated the older Intercolonial, but did not pass through American territory, though it only just missed it. The great bridge at Quebec met with disaster in 1907, but was finished at a cost of 22 million dollars in 1917. From Quebec, as Fig. 151 shows, the railway (which the government constructed) went through empty land all the way to Winnipeg, though later this was found to be valuable mineral country with fair soils in the *Clay Belt* (Fig. 79).

The Grand Trunk undertook to construct the western section through a separate company (Grand Trunk Pacific) from Winnipeg to Prince Rupert by way of the Yellowhead Pass. This line was completed in 1915, but the cost of the eastern section was so excessive that the Quebec–Winnipeg railway was left in the Government's hands and later became part of the Canadian National railways.

Meanwhile the Canadian Northern was buying up shorter lines

and linking them to form a third transcontinental (N—N in Fig. 151). Like its rival it uses the Yellowhead Pass, but on reaching British Columbia passes to the south-west down the Thompson valley to Kamloops, where it parallels the Canadian Pacific Railway to Vancouver. While there was every reason to build a fairly close railway-net in the fertile prairies, it is difficult to see the necessity for two new railways in the north of British Columbia at that early date, or for the duplicated lines in the vicinity of Hearst (Fig. 55). This railway also reached the coast in 1915, and the Canadian Northern now had 9,362 miles of track.

Owing to loss of traffic through the war, as well as for diverse other reasons, neither of these two new railways paid its way. The Canadian Northern group was taken over by the Government around 1918, while a few years later the Grand Trunk passed into Government hands. Both are now united as part of the Canadian National Railway—while the Canadian Pacific still remains a private company. In the vicinity of Hearst some of the lines only run a few trains in the week, nearly all the traffic being concentrated on the more southern railways (Fig. 55).

It would obviously be impossible to discuss the railway developments of the Dominion in later years in any detail, but a few words may be given to the way in which they are opening up the pioneer fringe north of the closely-settled lands. The chief of these new lines are charted in Fig. 151. In the far east we see that the rich hydro-electric resources have led to the extension of railways from the vicinity of Three Rivers north into the upper Saguenay region. Here are many new war plants, the most interesting being at Arvida which is indicated on the map. Reference should be made to Fig. 50, where this region is shown in more detail.

Due north from central Ontario is a new line to Moosonee on James Bay. This opens up some good timber lands, and gives direct access from the Clay Belt area to the ocean (Fig. 151). It has not, however, played any important part in the northern part of the lands through which it has been built (p. 251). A somewhat similar line, which, however, has already been described in some detail (p. 250), runs from Manitoba to Port Churchill on Hudson Bay. The railway to Waterways has also been discussed at some length on p. 258; while the line to the Peace River Block and the Alaska Highway—which ends at Dawson Creek—has been mentioned in the description of that interesting portion of the pioneer fringe.

Another line, quite isolated from the rest of the railways of the Dominion, leaves the coast at Squamish, some 30 miles north of Vancouver (Fig. 65). It was started with the intention of tapping the rather better agricultural land which lies just to the north of the

rich goldfields near Quesnel. It passes along an empty glacial valley from Squamish to Lillooet on the Fraser River. Near here it crosses the big river, and proceeds north via Clinton and Lake la Hache in another high-level glacial valley to Williams Lake. Here it once more reaches the Fraser, which it follows to its terminus at Quesnel. Although the road-bed to Prince George was largely completed many years ago, no rails have yet been laid, and motor-buses now link Quesnel with the farmlands around Prince George. The general environment of this part of British Columbia is described on p. 200.

F. AVIATION IN CANADA

The first flight by a British subject was made on 23rd February, 1909, when McCurdy flew his aeroplane for half a mile over the ice at Baddeck (C. Breton Is.). During the first Great War aviation progressed rapidly and 'Canada Aeroplanes, Limited' built no less than 2,900 planes. Air patrols from Halifax and Sydney were established in August 1918. In 1919 successful flights were made

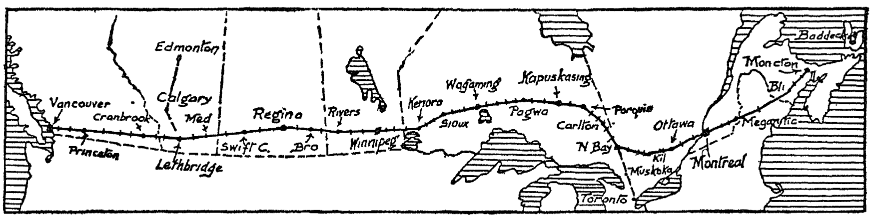


FIG. 152.—The Trans-Canada Air Service, showing the main airports, and indicating intermediate ports

for forest protection and survey in Quebec, and this work was much extended in the next few years. The Dominion was first crossed by air (in 49 hours) in October 1920. The discovery of oil at Norman Wells (p. 264) led to long air journeys in this part of northern Canada. The development of the goldfields of Rouyn (Quebec) helped to establish the first passenger-transport service in 1924. Twenty-three flying clubs were established in 1928 and 1929, and these aerodromes formed the nucleus for the Trans-Canada Airway (1938 *Year Book*). (See also *Canad. Geog. Jnl.*, Sept. 1950.)

Airway surveys for the proposed service across Canada commenced in 1928 in the prairie section of this lengthy route, and by March 1930 a regular service from Winnipeg to Edmonton was available, and was in operation until March 1932 when it was temporarily suspended. The necessity for main aerodromes and secondary aerodromes, and for radio-beams, &c., at frequent intervals along the Airway, meant that a long interval elapsed before the whole route could be used by the public. Regular operations between Winnipeg and Vancouver were possible at the end of

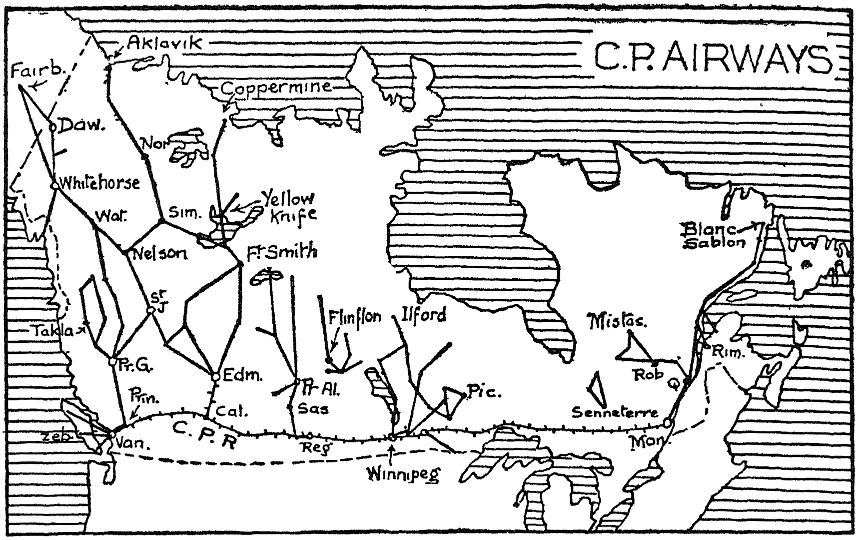


FIG. 153.—The chief Air Services maintained by the Canadian Pacific Airways. Most of them link to the main lines of the Canadian Pacific Railway which is indicated

1937, but the section east of Montreal was not ready for work at that early date. In 1937 there were 9 firms manufacturing aircraft, and 162 operating them. The total aircraft amounted to 604; of which 77 belonged to the Government, 114 were private, 71 were owned by clubs, and 342 were used for commercial purposes (Fig. 153).

On 1st April, 1939, a passenger service commenced between Montreal and Vancouver, a distance of 2,400 miles, which was flown in 15 hours. There are now many branches, such as that north from Lethbridge which serves Calgary and Edmonton (Fig. 152). Along this airway there are 8 public airports, 11 municipal airports, and 79 intermediate aerodromes, which are arranged at approximately 35-mile intervals. Most of these halts are indicated in the map in Fig. 152, which is based on one given in an article by J. F. Grant in the *Canadian Geographical Journal* for May 1939.

Transport in the north, remote from roads and railways, has long depended on the air services. In 1926 the mines of the Red Lake area in northern Ontario were linked by air to the railway, and in 1928 the first aeroplane flew over the Tundras of the North-West Territories. In 1931–2 many new northern mining fields were developed in large part by the new method of transport. In 1930 Canadian Airways was founded, and secured the first airmail in Canada; and by 1941 had carried 250,000 passengers. In 1937 a

mail and passenger service was inaugurated between Edmonton and Whitehorse. The formation of the Canadian Pacific Airlines in 1942 linked a number of these earlier air companies, and during the first year of its operations it carried 60,000 passengers.

These two large institutions, Trans-Canada and C.P. airlines, cover most of Canada, and their main services are indicated in the two maps (Figs. 152 and 153). The northern lines have been very busy of late with traffic concerned with defence measures, so that passenger traffic was considerably curtailed. In recent years the C.P. airlines have had an annual flying mileage of over 5 million miles. Some of the services flown regularly (mostly daily or twice a week) are as follows. Vancouver to Whitehorse, in eight hours, at a cost of $99; Vancouver to Port Alice; Vancouver to Victoria; Vancouver to Zeballos (in Vancouver Island), weekly; Whitehorse to Dawson City; Whitehorse to Edmonton in nine hours, daily; Edmonton to Norman Wells (five days a week); Norman Wells to Aklavik (monthly in summer); Peace River to Vermilion; McMurray to Stony Rapids. On the Shield the mines at Flinflon, Red Lake, God's Lake, and Pickle Lake are linked to the railways with regular air services (Fig. 153). In Quebec, Saguenay, Rimouski, and the north shore of the St. Lawrence have fairly frequent services.

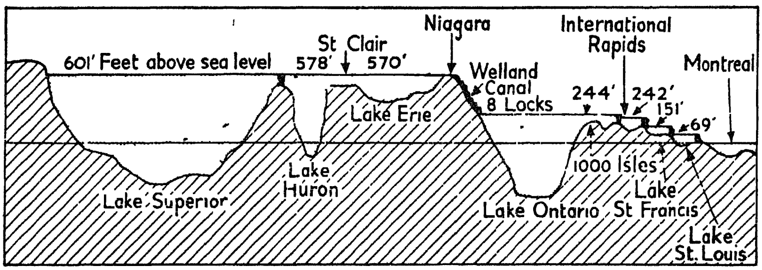


FIG. 153A.—Section along the St. Lawrence Seaway. It will enable ships of 26 feet draught to proceed 1,300 miles to the west end of Lake Superior. (From *Sun Herald*, Sydney, March 1954)

THE ST. LAWRENCE SEAWAY

In August 1954 this huge project to cost a thousand million dollars was officially begun by the Governments of Canada and U.S.A. The scheme involves the building of a dam and power house at the foot of Barnhart Island, a dam at the American Channel at Long Sault Rapids, and a control dam at Iroquois (Fig. 145). Total installed capacity will be 2,400,000 horse power, and full operation is planned for 1958. The present shallow locks between Montreal and Lake Ontario will be deepened to equal the depth of those in the western part of the Seaway. (See Fig. 153A, where the lifts to Lake Superior are charted.)

CHAPTER XX

POPULATION PROBLEMS, PRESENT AND FUTURE

Canada's Place among the Large Populations

IN this closing chapter the general conclusions gained in our lengthy study of the Canadian environment may be summarized, with a view to answering the chief question in Canadian geography, 'How can the future settlement of Canada be directed in the wisest manner?' In order to give a fair answer to this question we must examine the components of the Canadian population a little more fully than has been advisable in the preceding chapters. Questions of assimilation arise, as well as certain other problems, such as the advantages due to forming part of the British Empire; and some disadvantages through our belonging to an entirely different nation from our Anglo-Saxon relatives, across the 'undefended border', in the United States.

Let us first of all glance at the position of Canada among the major population-centres of the world. I have discussed this matter in several books and articles, for instance in my book *Our Evolving Civilization*, 1947; but it will not be out of place to repeat some of the major premises here. There are on our globe five belts of latitude, which differ so greatly that they have very different effects on man and crops. These are given in the following table:

LATITUDE AND CLIMATE

Rank	Name	Latitude	Character	Typical land
1	Best temperate	35–50	Excellent for man and crops	France
2	Cool temperate	50–65	Satisfactory for man, crops fair	Canada
3	Dry, semi-tropical	15–35	Desert in west and centre; very good in east	Australia
4	Wet tropical	0–15	Excellent for crops, poor for man	Equatorial lands
5	Polar	65–90	Very poor for crops or man	Tundra or ice-cap

If we accept the conclusions of the above table, then we see that Canada has an important place in the second-best belt, while France (and adjacent lands) and the United States and China are the best lands in the northern hemisphere. (The first two belts are largely occupied by ocean in the *southern* hemisphere.)

Most geographers adopt the general conclusions of Ellsworth Huntington that the annual isotherm for 40 degrees Fahrenheit accompanies the best *mental* work (Fig. 154). This runs through the belt of close settlement which marks the southern border of Canada—and this is a very valuable asset of the Dominion. (It also passes through Scotland, South Sweden, Moscow, and Vladivostok.)

The best conditions for physical work are, however, in warmer lands, according to the same geographer, near the average isotherm of 64 degrees. This runs through Los Angeles, Savannah, Lisbon, Athens, Persia, and Shanghai. Thus the United States is greatly favoured in its northern portion by being in the best belt for *mental* development, and in the centre by being in the best belt for *physical* achievements. Canada seems to be much too cold for the latter characteristics to develop to their highest degree.

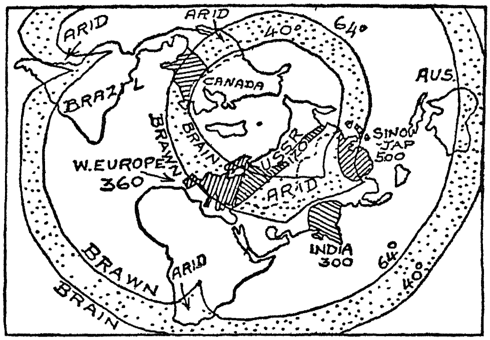


FIG. 154.—The five great population-centres are China, India, U.S.S.R., West Europe, and U.S.A. Probably the best climatic belts are those shown dotted

However, large and flourishing populations cannot develop in those *arid* lands, which occur in the centre of the continents; and this cuts out a large part of these 'optimum belts' which are based wholly on temperature. The three areas which are left, and which the author (who is somewhat of a determinist) believes will always continue to lead the world, are the United States, Europe (with U.S.S.R. much the dominant member), and China. At present these three centres of population contain approximately the following populations: the Sino-Japanese area about 550 millions; the European area about 500 millions; and U.S.A. about 130 millions. India, owing to its entirely anomalous position at the head of a warm ocean (see Fig. 154), has a good climate for crops but a poor climate for man. It has some 300 millions, for the most part of extremely backward peoples, whose poor mental and physical accomplishments must in part be ascribed to the fact that neither of the optimum isotherms crosses central or southern India.

In the great wars of the present century huge populations have not been of paramount importance. The power of a nation has depended very largely on its development of 'heavy industry', i.e. the supplies of fuel, power, iron and steel, and mechanical equipment, &c. Canada has made notable strides in this direction during the last few years, but if we examine her position at the beginning of the present great war, we find that her heavy industry is quite small compared with that of certain other nations I have prepared some interesting graphs, which I term *dynographs*, which bring out the relative powers of the nations in this respect (Fig. 155).

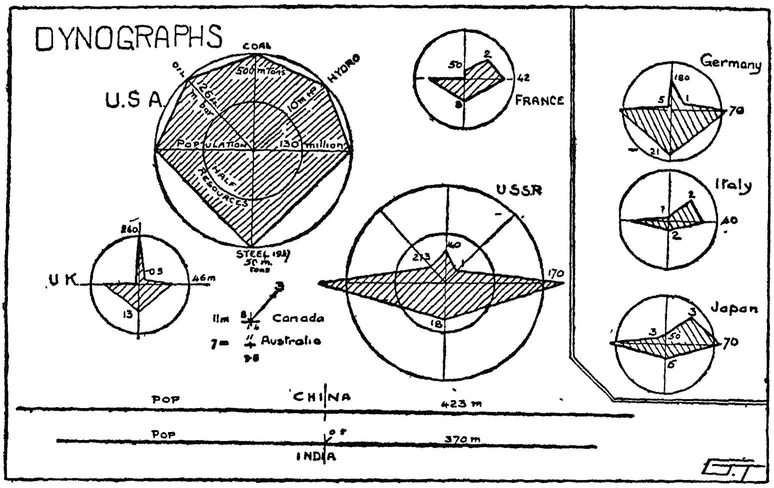


FIG. 155.—Dynographs, which show the relative values of heavy industry (and population) of the chief warring nations. Since 1939 data are used, Canada's dynograph is very small

Under the present conditions of industry it is almost a case of the United States 'first, and the rest nowhere'. In these dynographs the five axes represent the supplies of steel, oil, coal, hydro-electric power, and population. In the case of the United States the radius of each axis is taken as the amount produced in 1939; i.e. steel 50 million tons; coal 500 million tons; oil 1,264 units; hydro-electric power 10 units (and population 130 millions). In the other countries the radii are made proportional to those units assigned to U.S.A. Thus in the case of U.S.S.R. the population axis is longer in the ratio of 170 to 130; the coal axis is shorter in the ratio of 140 to 500, &c.

In the nine other nations whose dynographs are given in Fig. 155, U.S.S.R. with its huge population and fair production of coal and steel is the sole country which appears likely to rival U.S.A., for its

vast resources of oil, iron, and coal have not yet been fully exploited. The dynograph of the United Kingdom is very much smaller, and ranks with those of Germany, Japan, and Italy. When France was conquered by Hitler, England was faced with four nations each of approximately equal power—while in that dark hour neither U.S.A. nor U.S.S.R. had entered the world struggle. I know no graphic representation which shows so well as these dynographs the suicidal folly of Hitler when he brought in the two huge powers against his, so far, successful armies.

Four important nations, which are relatively young in the industrial sense, are also charted in the dynograph illustration. They are Canada, Australia, India, and China. None of these was of much importance in heavy industry before the present war. Canada, Australia, and India have recently progressed very rapidly in the matter of munition-making, though the statistics are not yet available. China will undoubtedly be of great importance in the future, since she has larger resources of coal and iron, and more intelligent labour, than has India. Australia in the long run must be the least important of the four, since neither her population, iron ores, nor labour supplies can equal those of the others. Canada has relatively good coal supplies; fair iron resources, if those in Quebec–Labrador (at the head of the Hamilton River) come up to expectations; and a much larger population-potential than Australia. Her hydro-electric powers are ahead of the other three in all probability. (Canada now ranks ninth in world petroleum.) Since most of the resources (as shown by the radii) were almost unused before 1939, the graphs given in Fig. 155 cannot show dynographs for these young nations of any significance.

Canada's Place in the Empire

The position of Canada with regard to the other large national or cultural groups of the world is of much interest, and may be briefly discussed with the aid of Fig. 156. Here is a map of the world so drawn that the land areas have true area and shape, but the oceans are distorted. (The Old World is cut through the middle of Asia.) Canada is placed in the centre of the map, and the lands are cross-ruled to show various associations of interest.

There are three large areas of the Empire (besides the British Isles) where the culture is wholly British. These are Canada with 11½ millions, Australia with 7 millions, and New Zealand with 1½ millions of people. The total white peoples of the Empire number about 70 millions, of whom 45 millions inhabit Great Britain. The total population of India is about 350 millions, but of these only about 160,000 are of European descent. In South Africa, out of some 7 millions, less than 2 millions are of European descent.

These areas are therefore distinguished on the map (Fig. 156) by close diagonal ruling. (India is now practically independent.)

Outside of the British Empire is a large group of nations which are of *European* culture; mostly Anglo-Saxon (in U.S.A.), or Russian (in the Old World), or Spanish (south of the United States). (Such areas are shown with *open* ruling.) Even the native peoples in these lands are rapidly adopting the dominant European culture. There is, however, another large portion of the earth's surface where the native peoples are not adopting the European culture in any large way. This is the case in much of Africa, which appears

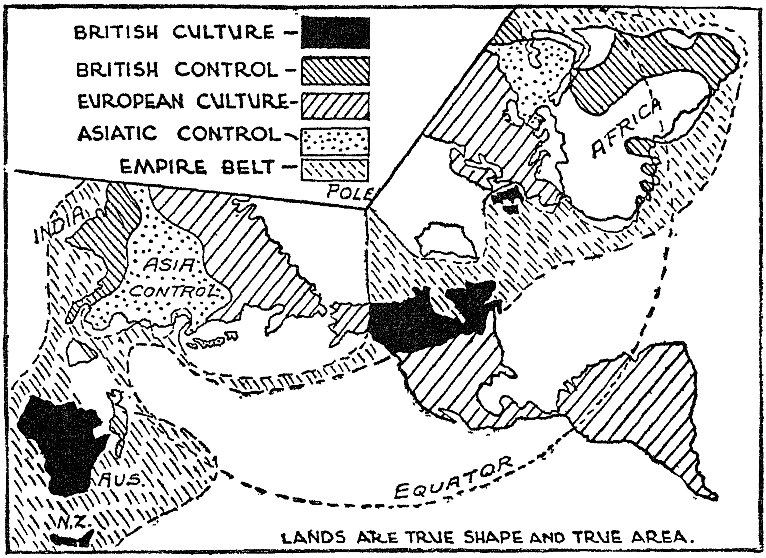


FIG. 156.—The position of Canada in the Empire. It is surrounded by lands where European culture is almost universal. (Data for 1940.)

blank in the map. Lastly, there is the considerable area in south-west and east Asia, where the folk have little or no European culture, and are controlled by non-European powers. This area is shown by dots in Fig. 156.

How does Canada lie with regard to these five classes? The scattered character of the British Empire is well brought out in Fig. 156, since I have placed a light diagonal ruling over the oceans where the British interests dominate. Canada is seen in the centre of two elongated 'wings', one of which extends to the east and includes Britain and the African possessions, while the other extends (very tenuously) to the west to Australia and New Zealand. India is, of course, on the other side of the world from Canada (though not its antipodes, which lies somewhat north of Enderby land in

Antarctica). Hence traffic with India is never likely to bulk much in Canada's history, partly because export goods like ours can reach India by much shorter routes from our trade rivals.[1]

Perhaps the chief lesson that Fig. 156 can teach us is that Canada is far from the vast Asiatic populations of India and China, and so is less likely than are some of the European nations to be affected by the abundance of low-grade labour in southern Asia which is going to bulk so largely in the economic problems of the next century. Canada is bulwarked by the enterprising peoples of the United States on the south. In the near east are the similar peoples of western Europe. To the north we are protected by the vast empty spaces of the Arctic, while to the west are the shores of Siberia with a highly progressive European culture due to the Russians. Australia stands as a guard beyond Japan to the south-west; and only to the south-east is trouble likely, where the vast negro population of Africa is not very happily controlled by a small minority of European rulers. Patience and tolerance, and an increasing measure of self-government (as education spreads), seem to be the policies indicated here, as in the other more distant storm-centre of India.

Earlier sections in this book have shown that Canada's chief disadvantage is her proximity to the North Pole. With the advent of widespread aerial navigation this may easily become something of an asset. Air traffic is not restricted by the distributions of seas and lands, but can move in any direction in the all-enveloping ocean of air. The Great-Circle Routes (which are the shortest air-routes) are therefore becoming of increasing importance.

Many maps have appeared in the last few years showing these great-circle routes plotted between various places. Unfortunately in most cases such maps are of little value for showing distances. However, there is one projection which enables us to plot the shortest routes as straight lines, and at the same time give distances fairly accurately from a given trade-centre. Such a map is shown in Fig. 157, where a gnomonic projection, with the tangent plane touching the sphere at Ottawa, is represented. All straight lines on this projection are great circles, and hence are the shortest distances between places linked by them. The map shows that to fly from Ottawa to Tokyo, we should not go west over the Pacific (*via* Honolulu), but almost *north*, over Hudson Bay, Aklavik, the Bering Straits, and then down the Asiatic coast to Tokyo. So also to go to Chungking, the recent capital of China, our route is neither east *via* India, nor west *via* Honolulu, but due north over the North Pole.

In the next or Air Age there must be a great increase in the air travel between the great centres of population and the great centres

[1] The large trade built up during the recent war is not likely to persist at the same level now peace is declared.

of machine production. These are south-east Asia and eastern U.S.A. respectively, and the airline joining them passes over Quebec, Baffin Land, Ellesmere Land, and the North Pole. In other words the ice-bound lands of the Canadian Archipelago are likely to become quite well known to the next generation.

In any gnomonic projection a given distance appears longer as we move from the point of contact (in the case of Fig. 157 at Ottawa),

FIG. 157.—Air-route chart showing true directions (broken lines) from Ottawa. Great circles appear as straight lines on this gnomonic projection, whose main features are shown in the inset. Circles about Ottawa show distances

but these distances can be shown by *circles* around Ottawa, and this has been done in Fig. 157. Hence we can find the air distances by the shortest route from Ottawa to any place in the nearer half of the world by such a projection as is here given. (The radii of the various circles in miles appear on the map.) Thus the North Pole is about 3,000 miles from Ottawa, and the same distance as Liverpool. Lisbon in Portugal and Para at the mouth of the Amazon are on the same circle as regards distance from Ottawa. To reach Moscow our great-circle route would pass almost over Leningrad, though most readers would think our shortest route would be *via* Berlin.

Distribution of Population in the Dominion

The major features of the distribution of population in the Dominion are charted in Fig. 158 from the latest *Year Book.* Here each dot represents 1,000 people, while the size of the populations of the cities is indicated by the large circles—which are repeated in the series at the foot of the map. The 'strip' character of the Canadian population is clearly brought out in this chart; while the contrast between the evenly distributed population of the prairies, and the much denser but restricted population of the St. Lawrence valley is also obvious.

Only in the Peace River area is this 'populous strip' some 600 miles wide. For most of a length of about 2,800 miles it is about 300 miles wide. Thus a first approximation of Canada's fairly closely-settled area (i.e. the 'populous zone' south of the boundary line shown in Fig. 158) would be 800,000 square miles. With a total area of 3,700,000 in the Dominion, it is clear that three-quarters of Canada has a completely negligible population, while the remaining quarter (i.e. the populous strip) with 11½ millions, has a density of about 13·7 per square mile. This is the present density of New Brunswick, Argentine, and New Zealand. The density of the Dominion, if the whole area be included, is 3·3 per square mile. (Data for 1951–54 are given on p. 12.)

The changes in population and density in the various provinces during the last thirty years are given in the following table:

Province	Area	1911 total	Density	1941 total	Density	*
Prince Edward Is.	2,184	93,728	42·9	95,047	43·5	1·4
Nova Scotia	20,743	492,338	23·7	577,962	27·8	15
New Brunswick	27,473	351,889	12·8	457,401	16·6	23
Quebec	523,860	2,005,776	3·8	3,331,882	6·4	40
Ontario	363,282	2,527,292	6·9	3,787,655	10·4	33
Manitoba	219,723	461,394	2·1	729,744	3·3	37
Saskatchewan	237,975	492,432	2·1	895,992	3·8	44
Alberta	248,800	374,295	1·1	796,169	3·2	65
British Columbia	359,279	392,480	1·1	817,861	2·3	52
Canada †	3,466,882	7,206,643	2·1	11,506,655	3·3	

* Percentage increase in density in 30 years.
† Including Territories with a population of 17,000 in 1941. Newfoundland omitted.

The 'saturation' of a province can be measured approximately by the changes in density shown in the last column of the foregoing table. There is a very interesting and regular change evident as we move from east to west across the Dominion. Thus Prince Edward Island is 'saturated', and so has hardly changed in density in thirty years, i.e. from 42·9 to 43·5, which is about 1·4 per cent

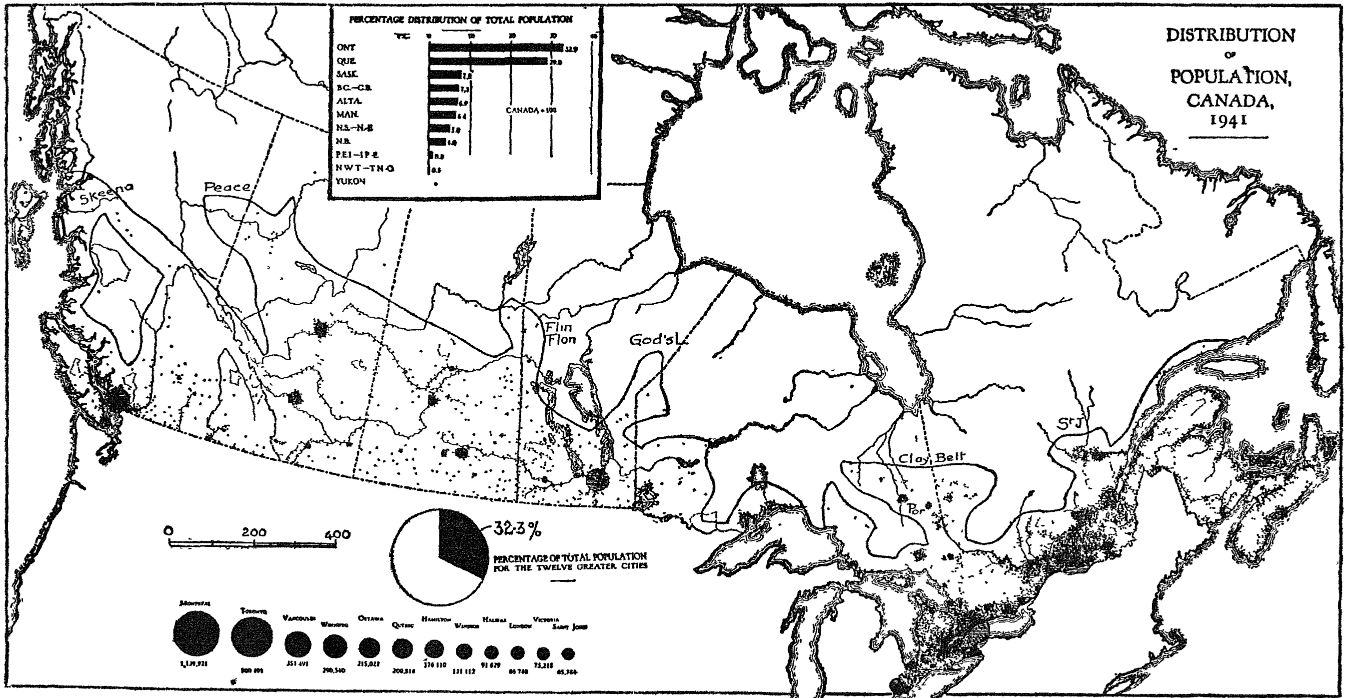


FIG. 158.—The distribution of population in 1941, each dot indicating 1,000 persons. From the *Canadian Year Book*, with the northern boundary added

increase. Rather low increases are found in the other Maritime provinces, which would suggest that the opportunities for newcomers were not extensive. In Quebec the density has jumped 40 per cent in the thirty years. No doubt this is in part explained by the huge families of the French people, but the industrialization of this province is also a factor. In Ontario the increase is not so great (33 per cent). As we move west to the new lands, the values increase steadily until Alberta is reached, where the density has made the largest increase of all, amounting to 65 per cent. British Columbia ranks second with 52 per cent.

It is worth dwelling for a short time on the very irregular northern boundary of this 'populous zone' (Fig. 158). In each case the reason for the expansion of settlement is very obvious. The most eastern is due to the St. John Lake *graben*, whereby good soils have been deposited in the relatively barren Shield. The excellent water-power of the Saguenay accounts for the dense population just to the east of the lake. The second 'extension' is due to the Clay Belt, with its enclosed rich gold-mines of the Porcupine Field. The third extension is of little importance yet, but may increase in value later. It occurs around God's Lake, but this extension has few folk living there. The next to the west is similar, but is the older mining field of Flinflon. A very promising extension on the borders of British Columbia is the Peace River agricultural area; and finally there are the small settlements along the Skeena River near the Pacific coast. But in the extreme west a vast area of barren mountainous country is included to the south of the Skeena, where the chances of any future settlement do not seem very promising.

PERCENTAGE OF EACH PROVINCE WITHIN POPULOUS ZONE

	Area	Within strip	Per cent
Prince Edward Is.	2,184 sq. miles	All	100
Nova Scotia	20,743 „ „	All	100
New Brunswick	27,473 „ „	All	100
Quebec	523,860 „ „	121,000 sq. miles	23
Ontario	363,282 „ „	125,000 „ „	34
Manitoba	219,723 „ „	66,000 „ „	30
Saskatchewan	237,975 „ „	144,000 „ „	61
Alberta	248,800 „ „	136,000 „ „	55
British Columbia	359,279 „ „	133,000 „ „	37

Rural and Urban Populations in the Provinces

The distribution of the major towns of the Dominion has been discussed in the chapter on Manufacturing. But the distinction

between rural and urban populations is one of significance throughout the civilized world. Forty years ago only 37·5 per cent of the Canadian population was urban, and 62·5 per cent was rural. At the 1941 census these figures had changed to 54·3 urban and 45·7 rural; showing that the sons of the farmers are flocking to the factories. The same tendency is obvious in the United States, where the urban dwellers constitute 56·5 per cent of the people. In Australia, which is usually assumed to be a somewhat pioneer country, the urban percentage is as high as 63·8, while in England it has risen to 78 per cent.

The following percentage table shows the way in which this change has come about in the provinces of Canada in the last thirty years:

	1911		1941	
	Rural	Urban	Rural	Urban
RURAL				
Prince Edward Is.	84	16	74	26
Nova Scotia	62	38	54	46
New Brunswick	72	28	69	31
Manitoba	57	43	56	44
Saskatchewan	73	27	67	33
Alberta	63	37	61	39
URBAN				
Quebec	52	48	37	63
Ontario	47	53	38	62
British Columdia	48	52	46	54

The Maritime provinces are still predominantly rural, though Nova Scotia is rapidly becoming urbanized owing to its coal pits at Glace Bay, &c. The prairie provinces have not changed very greatly in thirty years, though we may expect the coalfields of Alberta to make a change like that apparent in Nova Scotia in a few decades. Quebec and Ontario are definitely urbanized, as indeed was Ontario as far back as 1911. British Columbia, with its population so closely tied to Vancouver and Victoria (p. 179), has never been very rural.

Cultural Components of the Population

One quite important inaccuracy seems to be almost universal among statistical authorities, and that is the use of the word 'race' instead of the word 'culture'.[1] As regards European peoples

[1] The distinction between race and culture is discussed fully in two of the writer's books—*Environment, Race and Migration* and *Environment and Nation.*

there are three main ' races ', Nordic, Alpine, and Mediterranean. The racial traits belonging to these three groups, being biological, are inheritable. Hence the son of a pair of tall, fair, dokeph (narrow-headed) *Nordics* is of the same type ; while the dark, short, dokeph *Mediterranean* reproduces his kind, as does the sturdy brakeph (broad-headed) *Alpine*. But cultural traits belong to education (i.e. culture), and are often changed in one generation. Thus, many of the descendants of the English and Scottish soldiers, who settled in the Eastern Townships (Quebec), now have nothing but their names to remind them of their forefathers' culture.

It is quite absurd to talk of the ' French Race ', or for the matter of that of the ' English Race '. Folk from the east of England, and from the north-east of France both belong to the *same* Nordic *Race*. So also the dark men of Devon in England are ' Mediterraneans ', like the natives of south-west and south France. It would be less necessary to emphasize these inaccuracies, if the absurd ideas of the Nazis and their like had not involved so many references to ' race and blood ' and ' racial purity '. The writer hopes to see the terms *French Race* and *English Race* dropped from the vocabulary of educated Canadians. ' *French Folk* ' would be a more logical term.

One of the most interesting features of the Canadian population is the very great complexity of the cultural pattern. In Australia about 98 per cent of the population are of Anglo-Saxon origin. In Canada less than 50 per cent are of British origin, as is evident from the following table. Since no one but an anthropologist can make a true *racial* classification, I have arranged the groups according to their linguistic affinities, since language is the main feature in culture. The several cultural groups are arranged in order, according to the totals of their populations. (Data for 1951 appear on p. 12.)

At the first census of Canada, taken in 1666, there were 3,215 folk in the country, while in 1941 there were 11,506,655. This growth places Canada among the leading countries of the British Empire as regards rate of increase. The general increase in the population of European countries during the entire nineteenth century was approximately three-fold ; Canada equalled this rate of progress during the sixty years from 1871 to 1931 (*Year Book*). In the decade 1900–10 the immigrants alone numbered 1,800,000, and mainly for this reason the gain of 34·17 per cent in the total population of Canada was unequalled by any other country at that time. In the next ten years Canada increased by 21·94 per cent ; which was only exceeded by Australia, where the figure was 22·01 per cent. In the next decade the figure was somewhat reduced to 18·08 per cent ; while in the decade before the last census (1931 to 1941) there was a considerable decline in the increase (to 10·9), due to the long period of depression, and the very great reduction of immigration.

CULTURAL ORIGINS OF THE CANADIAN POPULATION IN 1941, ARRANGED IN GROUPS

Culture group	Nation	Total in thousands	Per cent	Group total	Per cent
1. British	English Scottish Irish	2,968 1,404 1,268	25·8 12·2 11·0		
Total				5,716	49·7
2. French	French (Belgian)	3,483 29	30·3 0·3		
Total				3,512	30·6
3. Slav	Ukraine Polish Russian Czech Yugoslav	306 167 84 43 21	2·7 1·5 0·7 0·4 0·2		
Total				621	5·5
4. German	German Austrian (Netherland*)	465 38 213	4·0 0·3 1·9		
Total				503	4·3
5. Scandinavian	Norwegian Swedish Danish Icelandic	101 85 37 21	0·9 0·7 0·3 0·2		
Total				244	2·1
6. Jewish 7. Italian 8. Hungarian 9. Finnish		170 113 55 42	1·5 1·0 0·5 0·4		
10. Aboriginal	Indian and Eskimo	126	1·1		
11. Asiatic	Chinese Japanese	35 23	0·3 0·2		

* Culturally allied (by language), but not included in group-total.

One of the two insets in Fig. 159 shows the number of immigrants entering Canada year by year since 1870. The peak year was 1913 with 382,841 immigrants. The graph drops sharply after the war started in 1914, and again in 1930 owing to the depression. The

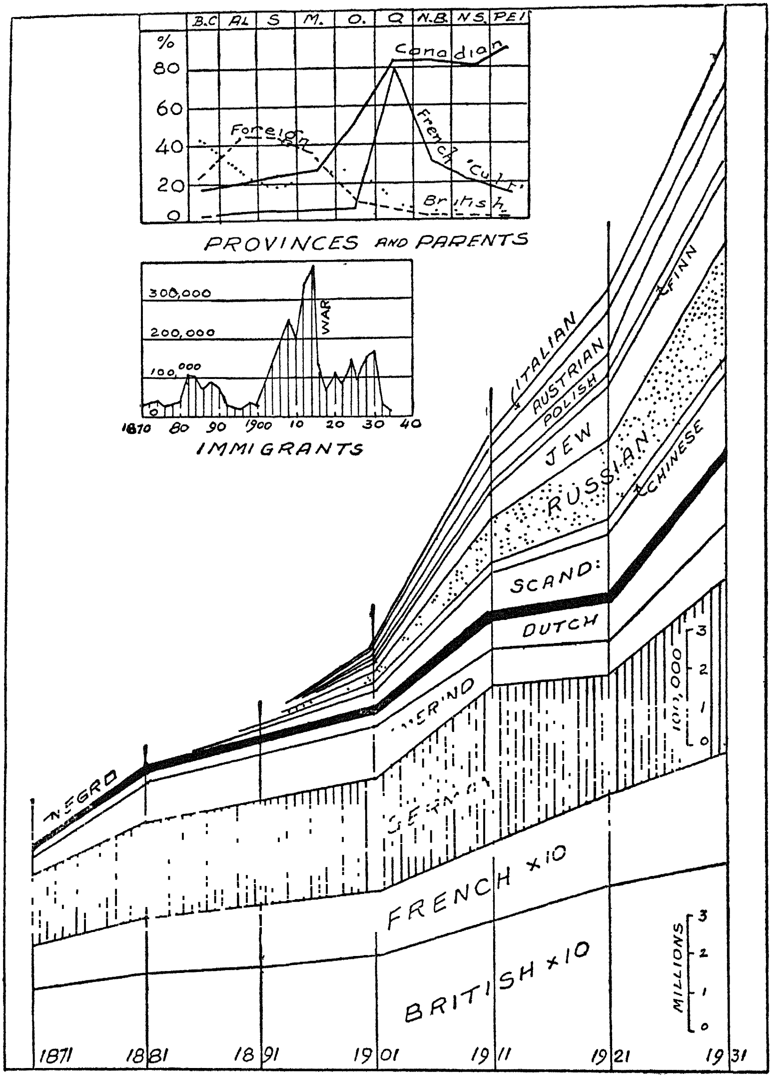


FIG. 159.—Cultural origins of the Canadian Population. The scale is reduced by ten for British and French. Inset: Variation of Parents in the nine provinces. (Note that the curve labelled 'Canadian' includes those of French culture)

second inset shows the population in the various provinces classified according to parentage. (In the graph only the folk having *both* parents Canadian, British, or foreign-born, are charted.) It is clear that only four provinces are of significance in this connexion.

These are Quebec, owing to its large proportion (80 per cent) of French culture; and the three prairie provinces, each with about 40 per cent of foreign origin. It is of interest that the settlers on the east coast are largely of British descent derived from *early* migrations, while those on the west coast are of British descent of *recent* date.

At the time of the conquest of Canada by the British in 1763, there were about 60,000 French in Canada. These were almost all settled on the littoral of the St. Lawrence, though many 'breeds', half-French half-Indian, were engaged in trapping around the Great Lakes. The British held the far northern region under the Hudson's Bay Company (Fig. 100), but this meant very little addition to the Canadian population.

Today people of French descent in Canada total 3½ millions, but this large group is almost wholly descended from the original French settlers, and there have been relatively few accessions since from France. There is, in point of fact, a considerable cultural cleavage between the French-Canadian and the Frenchman of present-day Paris. The Canadian still holds to the culture of pre-Republican France, and is a devout adherent to the Roman Catholic religion. He has little sympathy with the many schisms of French politics or with the agnosticism which today marks many influential Frenchmen in Europe. While in France the birth-rate (13·0) is the lowest in Europe, that of the French Canadian is one of the highest in the world. In the province of Quebec, which is almost wholly French, the birth-rate in 1942 was 28·0 per thousand, while in British Columbia (which is almost wholly British) it was at the same time only 19·3 per thousand.

The cultural composition of the Dominion has altered very considerably in the years following 1890, as the graph in Fig. 159 demonstrates. (In this chart the figures on the vertical ordinates represent *millions* in the case of the French and British, but only represent 100,000 for the smaller cultural groups.) From 1870 to 1890 Canadians were derived from Britain, France, and Germany, and there were few other folk except the aboriginal Amerinds. But after the opening of the prairies by the Canadian Pacific Railway in the 'eighties, the great immigration boom began, bringing in Scandinavians, Russians, Jews, Poles, &c., as is clearly shown in the right-hand side of the chart.

Habitats of the various Cultural Groups

Today the British and French groups together constitute 80 per cent of the population. This total amounted to 92 per cent in 1871; and has been steadily falling ever since, due to the influx of Continental Europeans during the past forty years. One would like to

speculate on the biological consequences of this mixing—which, as stated, is not occurring in Australia. The writer is of the opinion that it is all to the good—if time enough be given for cultural accommodation to take place. In various books dealing with the ethnology of Europe he has shown that the most progressive nations of the past (Greece, Rome, France, Britain, Germany, and Russia) are all 'hybrid' in the sense that they have developed on the borders of the three races already specified.

Much has been written of the superiorities of the Nordics, not only by Germans but by a number of French and Americans. The writer has a 'hunch' that the broad-headed Alpines are slowly 'inheriting the earth'; [1] but one may be sure that the three races in Europe are all well-endowed with valuable traits for the advance of civilization. In our present state of knowledge it is safe to assume that (biological) race—as far as Europe is concerned—is a negligible factor. Applying this thesis to Canada, we should feel glad of the influx of central Europeans, such as the south Germans, Austrians, Rumanians, Swiss, Ukrainians, &c., who are all broad-headed *Alpines*. Of course, the Dominion experiences some 'cultural indigestion'; but this is due to our trying to assimilate the folk concerned in too great a hurry, rather than to any real lasting disadvantage due to our mixing cultural or racial elements.

The official atlas of 1915 distinguishes between folk of English, Scottish, and Irish descent—which seems a matter of minor interest to most geographers. However, the charts show that there is a remarkable concentration of folk of Scottish descent in the half of Nova Scotia north-east of Halifax, which justifies the name '*New Scotland*'. Indeed, it is stated that a journal in Gaelic is published in this province. There does not appear to be any such large area of Scottish folk anywhere else in the Dominion.

Folk of Irish descent dominate in a large area of Ontario extending between Ottawa and Peterborough; and there is another region with Irish settlers between Orangeville and Owen Sound. On the other hand, south-west Nova Scotia, and (in Ontario) the coasts of Lake Ontario and Lake Erie are predominantly English; and this is given as the type of settler throughout most of British Columbia in the same atlas.

The present habitat of the French Canadian is shown in the inset map in Fig. 160. They still congregate around the St. Lawrence, from Ottawa east to the ocean; but there are only a few French townships in Nova Scotia at three widely separated areas. One of these is the extreme north of Cape Breton Island, another lies along its southern shore, while the third is near Yarmouth in

[1] See p. 461 in *Environment, Race and Migration* (1937), and Fig. 31 in *Environment and Nation* (1936). Also *Our Evolving Civilization* (1947).

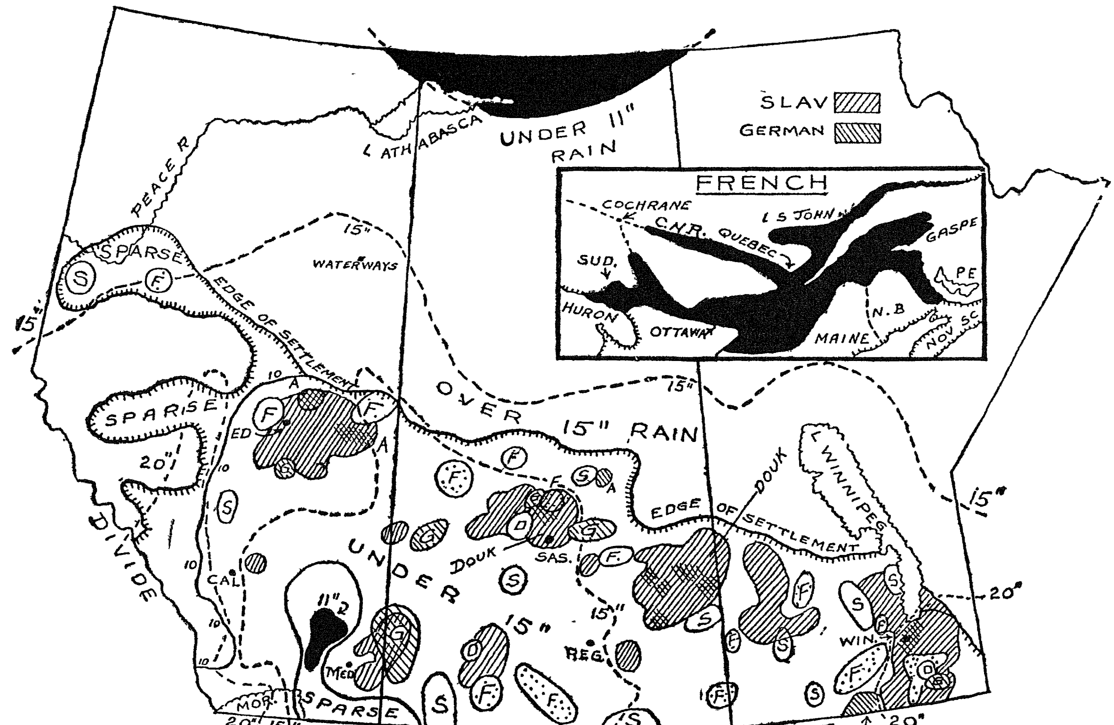


FIG. 160.—Foreign Culture Groups in the Prairie Provinces. Notice the abundance of Slav settlements on the northern margin. Dutch, Scandinavian, and French are shown by initials. Inset is a map of the French folk in eastern Canada

the south-west of the province, and the total number is about 66,000. In Prince Edward Island there are about 15,000 folk of French culture, found mostly in the extreme north-west end of the island. In both provinces the proportion is only about 10 per cent of the total population.

In New Brunswick the proportion rises to 36 per cent, and in Quebec to 81 per cent. In the former province all the east coast townships north of Shediac are French, as well as those along the northern border of the province. This distribution is shown fairly clearly in the inset map in Fig. 160. They are all descendants of the original French conquerors of the country, and are gradually spreading into the other portions of the province; partly because of their high birth-rate, partly because they are satisfied with a lower standard of living than the British, partly because they have less desire to move away 'to better themselves'.

Throughout Quebec the folk are dominantly French, though there are nearly half a million British scattered through the province. The largest group of British is found in Montreal, where the proportion of French-Canadian citizens is about 64 per cent (Tanghe), though by no means all the rest are British by descent. Only a few parishes near Thetford and Lachute are shown as with British majorities in the cultural maps of the official atlas of 1915. It is interesting to note that in 1848 Montreal contained 19,041 French Canadians, and 24,531 folk of British descent (Maurault).

In the province of Ontario the French have spread rather rapidly along the railways in the Sudbury–Timmins area, so that the British in southern Ontario have a belt of folk of French culture across the north of their territory (inset map in Fig. 160). This is mostly rather poor farming country where the French are perhaps more easily satisfied than the British, and there are of course many French Canadians working in the huge mines of this region and in the paper- and pulp-mills also.

Before passing to the prairie provinces some of the other culture groups in the east may be considered. Reference to the left-hand side of the graph in Fig. 159 will show that long before the opening of the prairies (about 1880) there was a considerable population of Germans in the east, as well as some Dutch and negroes. An old centre of German folk is Lunenburg, about 30 miles west of Halifax. Many of the members of the famous fishing fleet here are of German descent, but they have long become Canadian in their outlook. Another similar centre is found near Kitchener (Ontario), whose name was changed from Berlin a few decades ago. These folk are Mennonites who migrated from Pennsylvania over a century ago. They are followers of a Dutch Reformation teacher, Menno Simons, and their beliefs are much like those of the other Protestant sects,

save perhaps their strong objections to military service. Another centre north of Kitchener is Hanover, but here there has been no change from the original name of the town. In the vicinity of Pembroke on the Ottawa River there are also a number of townships with a considerable proportion of Germans.

Turning now to the west, the prairie provinces offer a picture almost unique in world-settlement. The United States in its days of early settlement had not such a polyglot mixture; though of course today, just over the border from the prairie provinces, Americans face almost identical problems. Reference to Fig. 160 will show that Slavs (Ukrainians, Russians, and Poles) are in a large majority among foreign culture groups. Germans and Scandinavians are abundant, while the French-Canadian group is much less significant.

The French immigrants into the prairies were largely brought in owing to the zeal of the French priests, who had long maintained missions to the Indians and the half-breeds. Thus St. Albert Mission was founded, near the Edmonton of today, as early as 1843. The fur-trade and the buffalo were the main interests till the coming of the railway; and the priests greatly helped the trapping population during the difficult transition period before agriculture was firmly established.

In 1875, before the Canadian Pacific Railway reached the province, German settlers arrived in Manitoba. In the summer of that year 'a line of camp-fires extending for miles and miles announced one evening to the lonely settlers of Pembina that 6,000 Mennonites had located on seventeen townships'.[1] These folk had first migrated to south Russia in 1783 and had then moved to Canada in 1875.

The first farms of the Mennonites were arranged on the early European plan; each farmer having one village plot, a strip of good land, and a portion of hay-land remote from the village. Each village had its own 'Colony Church', and elected its own headman. But today the general pattern of the Mennonite village differs little from that of the adjacent Canadian towns. In 1882 a railway reached them, bringing settlers of various other cults. A daughter colony was then established at Rostherne near Saskatoon (Fig. 160); and in 1892 many left for Mexico. Winkler, Morden, and Gretna, all south-west of Winnipeg, are their chief centres in Manitoba.[2]

The Scandinavians and Russians, who constitute such a large proportion of the prairie population, have almost all arrived since 1900. Between 1906 and 1911 railways linked Edmonton, Saskatoon, Dauphin, and Winnipeg, i.e. along the northern frontier. As we have seen, this is the region of the best soil, and the rainfall is rather better than along the main line of the Canadian Pacific Railway.

[1] J. S. Woodsworth, *Strangers within our Gates*, Toronto, 1911.

[2] An excellent account of these culture groups will be found in C. A. Dawson, *Group Settlement in Canada*, Toronto, 1936.

The early immigration of the Slavs into the prairies may now be briefly described. In 1801 the Czar allowed the Doukhobors, an unorthodox religious sect, to settle near Azov in south Russia. They refused to obey the requirements regarding military service, and from 1826 to 1840 many migrated to Armenia. In 1899 over 7,000 came to Canada with the help of the Quakers on this continent.

Their chief settlements were in Saskatchewan at Blaine Lake near Saskatoon, and near Kamsack on the eastern border. (These localities are indicated by DOUK. in Fig. 160.) As usual the arrival of the railway (in 1903) brought in many rival settlers. Nowadays only about 30 per cent of the population is Doukhobor in their original districts around Verigin and Saskatoon, and they are much outnumbered by Slavs of the Greek Orthodox Church. In 1908 a daughter colony was formed in British Columbia near Castlegar. Here there are 6,000 Doukhobors of the more primitive type, while the 7,000 who remain in Saskatchewan are gradually acquiring more of the general Canadian culture.[1]

The Mormons from Utah possess a belt of country about 50 miles by 75 miles on the southern border of Alberta (Fig. 160). This is largely a grazing country, but irrigation is an important feature also (Fig. 128). Cardston is one of their 'Holy Cities' and possesses a striking Temple. It is the centre of about 13,000 Mormons. In the new Peace River country (at Demmit near Grande Prairie) there are communities of Czechs who have settled there in the last five years; while there are several small towns where the French predominate in the vicinity of Falher.

Professor Lower, in his book, *Settlement and the Forest Frontier* (Toronto, 1936), sums up the culture problems in Northern Ontario as follows:

> Between the French and the English little real community of feeling or action does or can exist. Scandinavians will quickly melt into Anglo-Saxondom as they do everywhere; and the Germans will do so too, though rather more slowly. Even the Finns are said to learn English rapidly, and in general to adapt themselves to Canadian ways.

He is not, however, very sanguine of any rapid amalgamation of the Poles and Ukrainians.

Forecasting Population

In the section dealing with the development of the prairies I discussed briefly the views of such men as Palliser, Macoun, and Mavor as to the future of these—in their time—almost completely empty lands. I have a firm belief that such forecasts are very valuable, and I think that Canada benefited from the attempts of

[1] For an account of the Doukhobor settlement, see the writer's paper on 'British Columbia', *Geog. Rev.*, New York, 1942. (See also Fig. 72.)

those pioneer scientists. I have no hesitation in trying to help Canada in the same way with a forecast for Canada—say in a hundred years; and I have no doubt that my views will be opposed by a number of Canadians of real standing, who think my conclusions are somewhat utopian.

It is not irrelevant to point out that some thirty years ago I published views as to the future of Australia, which so displeased the 'powers that be' in Western Australia, that my book was black-listed in the schools of that large region. Today I can safely say that Australians have adopted most of my conclusions—for instance, that it was unlikely that the population would grow much beyond 30 millions—and much more pessimistic views are published and received quite calmly in these more enlightened days.

In Australia there was an unwarranted optimism—as I saw it—with regard to the vast empty lands of the centre and north, which developed for two reasons. Tropical Australia is almost in contact with the realms of the dense populations of Asiatics to the north. It was rightly felt that Australians should colonize these areas as soon as possible, or the Asiatics would do it for them. Those in authority seemed to curb criticism of these northern tropical lands, which to this geographer seemed to hold out no hope of close settlement by British stocks. They subsidized such misleading tomes as *Australia Unlimited*,[1] which was a fine example of journalism, but no reliable guide to future settlement. Furthermore, it was very difficult before 1917 for the average Australian to see empty Australia for himself. There were no transcontinental railways, and it was not till the dawn of the flying age that many folk crossed the arid interior, and obtained a comprehensive view of this huge region.

In the case of Canada we have an even larger extent of empty land; as a preceding section in this chapter shows—all but 800,000 square miles can fairly be described as empty, even in 1945. But there has been little tendency on the part of those in authority to claim too many virtues for these lands. I was pleased to find that the Ontario government is preventing too hasty settlement in the Clay Belt, and ensuring that new settlers fill up areas *adjacent* to those already sparsely settled, before distant blocks are thrown open. The Dominion Government has produced a fine series of memoirs on the Territories, in none of which is there any attempt to bring about rapid settlement. There is, of course, no particular danger of any expansion of foreign peoples to the north of our empty lands—say from Siberia—who would be likely to anticipate our own settlement of Empty Canada.

Indeed, it is my experience that those in authority are wisely

[1] E. J. Brady, Melbourne, 1918.

frowning on the rather wild statements which from time to time are made with regard to 'potentialities' of the north. Such has certainly been the case with certain oilfields and analogous mineral areas. With regard to the totals of coal in Alberta, the latest official figures are much less than those allowed some thirty years ago. For instance, the accepted textbook on the *Mineral Resources of Canada* [1] quotes Dowling's figure of 1,072,627,400,000 metric tons as the reserves of coal in Alberta. For many years I have been using a lower figure of 667,000 million tons [2] for the same reserves, which is considerably greater than the combined reserves of Germany and Poland. Recently I believe a re-appraisal of the Alberta reserves has led to a great reduction of these figures. J. A. Allan is of the opinion that the coal *which may be won* from Alberta's huge reserves can be set down as 46,562 million tons, a reduction to 4 per cent of the enormous reserves formerly quoted. Even so, it ranks with the coal resources of Donetz (Russia) or of Bohemia or South Wales; and there is nothing yet in Alberta to compare with the industrialization of these three European regions.

What the geographer tries to do is to integrate the possibilities of the regions of a country, and then to *grade* them so as to show which should be the next to be developed. He tries to point out that settlement proceeds in stages, which are often repeated in different regions in the same *order*, but which never characterize all the regions of a large country at the same *time*. Thus, we may state that much of Keewatin is today in the 'early pioneer' stage, and resembles southern Ontario as it was before the Loyalists arrived around 1780. The Mackenzie River Settlements may be compared with southern Ontario as it was a few decades later. The Peace River Settlement today is like southern Ontario as the first railways traversed it in the 'fifties. The smaller prairie towns today resemble those of southern Ontario at the close of the last century. In other words, we have here an example of the 'Zones and Strata' concept; whereby the *zones* of culture as seen today (and the buried *strata* seen, for instance, in long-established Toronto) give us a fair picture of the evolution of settlement in the rest of the Dominion.[3]

The geographer should therefore be in a good position to grade the lands; but he has another valuable approach based on the study of *homoclimes*. Almost every region in Canada can be compared with a region elsewhere, in which the climate (and to a lesser degree the other elements of the environment) is similar. Such pairs of regions

[1] By Elwood S. Moore, Toronto, 1929.

[2] Based on the *World-Wide Survey of Resources*, Dresdner Bank, Berlin, 1927.

[3] This concept was developed at some length in my Presidential Address to Section E, B.A.A.S., Cambridge, 1938.

are homoclimes, and a good deal of attention has been paid to this concept in earlier chapters of this book, and will be taken up again shortly.

Future Population of Canada

The conclusions of the writer with regard to the habitability of the Dominion are indicated in the five maps which appear as the frontispiece to this volume. They are based on all the climatic and other environmental factors which have been discussed in earlier chapters, but it may be well to summarize the various features in each of the four small key-maps.

The first map (*top left*) shows the *build* of Canada, in which two of the main divisions are not favourable to close settlement. These are the Shield and the mountain region—which is indicated by the area over 3,000 feet high. Not all districts of these two vast divisions are useless for important settlement, but they are much less attractive than the other two major divisions—the geosyncline (or Mackenzie-Saskatchewan Downfold); and the fringe of younger rocks in the south-east corner of the Dominion.

The second small map (top right) shows the *rainfall*; which, as mentioned before, is in general fairly well distributed. Only in the far north, where other factors are inimical also, is there a large area with a rainfall below 11 inches. However, in the narrow valleys of the mountain area, and along the Saskatchewan–U.S. border the lack of rain is the major factor in prohibiting a fairly close settlement.

The next small map showing the *July Temperature* is one of the most important as regards the spread of settlement. The 'hot loop' projecting down the Mackenzie valley is one of the most remarkable isopleths in the continent. Notice the breadth of the zone between the 57 and 61 isotherms near the Mackenzie, and compare it with the narrow space in Ontario and Quebec. It is this chart which lends support to our belief of a considerable expansion of important settlement into the far north of Canada in the future. As far as summer temperatures are concerned, the climate is more attractive on the Arctic Circle than it is in the long-established fishing villages along the north shore of the Gulf of St. Lawrence from Mingan to Blanc Sablon (p. 244).

In the last of the four small maps is a simplified map of the *Natural Vegetation*—always the best key to future settlement. Here again we see the advantageous conditions in the lower Mackenzie valley as compared with those to the east in the same latitude. The definite Prairie region is rather more restricted than is usually shown on vegetation maps; and I have added the broad belt of Aspen-grove and Mixed-woods (in which Aspen poplar is dominant) as an important zone between the true coniferous Taiga, and the true grass-covered prairie. Of course there is much aspen north of this

belt, but I was struck with the change in the appearance of the country as I traversed the Peace River area in the summer of 1944. Most of it could hardly be called Taiga, if we think of the latter as essentially a conifer (i.e. spruce or pine) forest. This *Aspen* woodland seems on the whole to be much more favourable for close settlement than the Taiga of the Shield in similar latitudes in Quebec and Ontario.

One or two other major factors determining settlement are indicated on these generalized maps. For instance, in the map of Build, the main coalfields are charted, and much the most important is in Alberta. As stated, according to the Geological Congress at Ottawa in 1911, this field then ranked among the top three or four in the world as regards total resources. Although I have earlier quoted Allan's much lower figures for Alberta (using a figure of only about 4 per cent of the earlier estimate), it is not at all clear that later estimates of the other big fields—using Allan's rather drastic criteria—would not bring down the figures say of certain U.S.A. and European fields in something the same ratio. (This would leave Alberta still one of the great coalfields of the world.)

I have not inserted the oilfields in these maps, for the Canadian oil production is only about one-fifth of that needed in the Dominion, and is not large compared with the output of many other countries. In 1939 Canada's production ranked thirteenth among the world's oil-producing nations. The insertion of the words 'Metals' and 'Hydro' on two of the maps shows that the otherwise unattractive Shield had some assets of great value. Of the two the hydro-electric power is of course constant, and will be widely used in the future; whereas the metal mines, in general, do not last more than a decade or so. The Taiga in North Quebec is less favourable than in the west.

Canadian Homoclimes in U.S.S.R.

Before discussing the main map in the frontispiece—that suggesting where the future population of Canada will dwell—it will be well to make use of a geographical technique which I have used in many of my later studies of the possibilities of various regions. It is based on the study of homoclimes, i.e. regions of similar climate. We may not be able to forecast the output of metals in the Shield since 'Gold is where you find it'; but we do know now fairly accurately the main elements of the climate. These control agriculture, and this (apart from extensive coalfields) is the major factor in producing a stable close settlement.

In order to arrive at the comparative possibilities of U.S.S.R. and Canada I have placed some of the main controls on a map of U.S.S.R. in Fig. 161. The two main isopleths shown there are for 56° F. in July and for 64° F. in July. This includes a broad belt

which is ruled diagonally in Fig. 161. Even more important is the line which denotes the northern boundary of some agriculture, as given by Gregory and Shave in their recent textbook *The U.S.S.R.* (Harrap, London, 1944).

Since some of the areas with a fair temperature (above 56° F. in July) are arid, these are marked with dots, and are not ruled to show that they are possible sites for settlement. In the companion map for Canada I have shown that there is a similar broad belt of fairly good summer temperatures (56° F. and 64° F.) which can be equated with the ruled area in U.S.S.R. in this first approximation.

Some of the local experiments made by the Soviet folk in this debatable area are well worth quoting from Gregory and Shave.

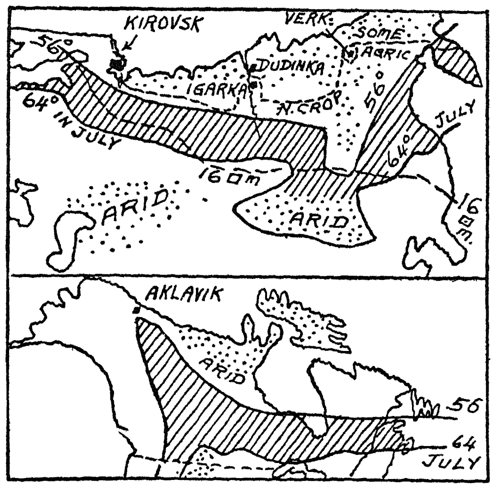


FIG. 161.—A comparison of similar Climatic Belts in U.S.S.R. and Canada; showing also the northern limit of crops in Siberia, and the 16 per square mile population-line. (See reference, p. 35.)

At Kirovsk in the Kola Peninsula, well north of the Arctic Circle, a large State farm produces vegetables for most of the Murmansk region. One farm near latitude 70° N. has given a yield of 8 tons of potatoes per acre. Another State farm in this area harvested in 1938 nearly 13,000 cwt. of vegetables and 28,000 cwt. of potatoes. The development of the apatite mines in the Shield near Kirovsk is of the greatest significance to northern agriculture, since excellent chemical fertilizers are manufactured from this mineral. (Such apatite deposits occur in the Canadian Shield.)

Igarka on the Yenesi River was established as late as 1927 as the chief port (Fig. 161). By 1939 the population had risen to 20,000, though the town has just the situation of Aklavik—about 120 miles north of the Arctic Circle. Ships enter the harbour in July and

must leave it by October. However, the sawmills can work during the winter, as they will some day at Aklavik. The people are supplied with food from a State farm just outside the town. Oats, vegetables, and hothouse tomatoes are grown. There are 350 cattle, 200 pigs, and many hens. At Igarka there are less than 90 frost-free days in the year; but surprising results have been obtained by the use of special seed, which is *vernalised* before being sown. Wheat, barley, and oats, are cultivated in the open, although the subsoil is frozen a short distance below the surface.

Near Verkhoyansk—which has far colder winters than anything experienced in Canada—there is an agricultural station where some success has been met with in experimental crops. There is a population of about 5,000 in the district based mainly on mining, but the possibilities of useful crops in this north-eastern district of Siberia seem less likely than in the west, south of Igarka.

Our chief interest, however, is in the future populations of this area. The Soviet authorities—who have a better appreciation of broad geographical principles than any other nation—before the war were of the opinion that they would have a population of 340 millions by 1975.[1] Most of this increase (above 170 millions) must obviously be realised in the new lands of Siberia. Yet there are plenty of Canadians who do not seem to expect any notable increase in the similar belt which I have indicated in Fig. 161 in north central Canada.

In the map of U.S.S.R. I have inserted the northern limit of fairly dense population (16 per square mile) as given in Philip's *Senior Atlas*, 1926. All along the Trans-Siberian Railway is a belt of country with a density about that indicated. The density of one per square mile agrees approximately with the line showing the northern limit of crops (in Fig. 161). These two densities represent Siberia *today*—not fifty years hence when peace has given the Russians time to expand on a large scale. Hence it does not seem out of order to assume something like these densities as possible for similar lands in our Dominion. In 1954 my Presidential Address (to geographers at Canberra) of 40 pages dealt with the relative habitability of Canada and Australia (ANZAAS 1955).

Habitability of Canada

In the main map of the Frontispiece I show my conclusions as to the future population of Canada, when it is 'saturated' to about the extent that Europe is at present. It is of course a much generalized map, and only an approximation to the real map—which may perhaps appear something like this in the year 2045! However, it is always wise to 'have something to aim at', and this will direct attention to the probabilities of Canada's growth, even though I am

[1] Bruce Hopper, *Limits of Land Settlement*, p. 91, Paris, 1937.

sure that it will be possible to get closer approximations to the 'saturated population' of Canada as the decades pass.

In the United States the eastern industrial areas, where both coal and crops are plentiful, and where the climate is suitable for dense white settlement, we find a population density of about 40 per square mile. I have suggested that this will be reached in the vicinity of the coal-mines in Nova Scotia, and along the St. Lawrence Waterway. Most of the eastern settlements will continue to be agricultural as far north as the Clay Belt, and I suggest that the population in this area will be between 18 and 40 per square mile. The plateau areas near or south of the Shickshocks in Quebec and New Brunswick, and behind Quebec city will never have a noteworthy settlement.

I have inserted the northern limits of oats and barley—which will I think enable a population near 5 to the square mile to develop in the distant future—much as settlers in this sort of country have demonstrated in Finland and north Russia. In Siberia, as I have pointed out, the population along the northern limit of all crops (potatoes, &c.) is about 1 per square mile in Siberia today. We may surely assume that it will have reached this figure in Canada in less than a century on each side of James Bay.

Hydro-electric power and a crop of conifer timber—harvested several times in a century—will characterize settlement in northern Ontario and north central Quebec. Mines help greatly to open up a pioneer region and cause the start of small farms, as I have suggested, but do not in general produce permanent settlements.

In Manitoba the same criteria are adopted. The rich black soils of Glacial-Lake Agassiz will support a dense farming population of more than 16 to the square mile; indeed much of it approaches that at present. All the conifer forest, according to the Russians (Fig. 161), can support some sort of a crop as the population pressure to the south increases. I have inserted the '1' and '5' density-lines in accord with the Russian evidence. The conditions are almost the same in Saskatchewan as in Manitoba, save that the proportion of sterile Shield is much less. But for the first time we meet with rainfalls which are rather low and variable; and this accounts for the decrease in the future population as we move from the centre to the south of this province (main map in Frontispiece).

In Alberta the abundant coal cannot be ignored much longer as a source of power on a large scale. There is no need to traverse the discussion already given on p. 421. There are so few little-used coalfields left that our great heritage will soon be fully exploited. It may be possible to gassify the coal in the mine—as has been done both in Germany and Russia I believe—and so cut out much of the cost of labour and haulage. If Russia can haul iron ore from Magnitogorsk to Kuznetsk, why cannot we do the same with

regard to Ontario iron ore? We can erect blast furnaces at the *iron*-mines, as well as at the coal-mines, as is done in Whyalla, South Australia, and elsewhere. Hundreds of factories based on the agricultural, forest, and mining resources of western Canada can well be developed—as is happening in central Siberia. But all of this will take time, perhaps a century; so that my forecast does not suggest what may result from the influx of post-war immigration.

As regards British Columbia it is difficult to make even an approximate forecast. Today almost all the population is confined to the southern quarter of the province; and indeed a very large proportion of this is within 70 miles of Vancouver and Victoria. I can see no reason why this general arrangement should not persist for many decades. It is the result of the topography and the climate, and these will not vary enough to alter settlement conditions in the next century. However, there is a large area of relatively good agricultural land, which is quite empty, in the vicinity of Prince George, and I have suggested that this will fill up to a density between 5 and 16 in the distant future. The abundant rains, fair temperatures, and considerable hydro-electric power of the large coastal areas cannot counterbalance the disadvantages of a rugged topography; though paper and lumber will be valuable assets, which should not deteriorate in amount if wise conservation is taken in hand.

I look forward to a considerable farming population in the vicinity of the lower Liard—where the experience of the Peace River is going to be repeated in the next generation. A 'tongue' of fairly dense population is shown projecting down the middle Mackenzie valley. But obviously these outlying 'pioneer' regions should not be occupied until the population-pressure from the south is a good deal greater than it is likely to be for the next generation.

Beyond the 'Limit of Root-crops' line I do not see any hope of notable settlement. It is true that a great deal of it is likely to be converted to pastures for tame caribou and musk-oxen. But this will add little to the human settlement. The new herds of reindeer which were recently transferred to the delta of the Mackenzie have only led to the rise of one settlement of about half a dozen houses at Reindeer Reserve. Still this endeavour to start a new pastoral industry, mainly for the benefit of the Eskimo, is greatly to be commended, even if it adds little to the population of the Dominion.

What is the optimum population for Canada? This is a much more difficult problem than arranging in 'order of merit' the various regions of the Dominion. A good many years ago I developed a technique for answering this question, which is described at some length in my book *Environment, Race and Migration* (3rd edition, Toronto, 1946). In the last part of this volume I set myself the question, 'How many folk will the new lands of the world contain

when they are as " saturated " as is Europe today ? ' I worked out the controls governing population in Europe ; and then found the similar distributions of controls in the debatable lands.

This research has often been quoted—e.g. in Bowman's *New World* where the final map may be consulted. Hence, it seems needless to do more than give the final approximations which I worked out. Taking the 500 millions of Europe as a standard, my graphic method showed that U.S.A. had about the same potentialities for settlement ; so that if Americans were satisfied with the rather low standards which obtain in most of Europe, U.S.A. could hold 500 millions in the distant future. If they desire to hold to the higher American standards of living the total populations will approximately be halved.

For Australia on the European standards the figure came out 60 millions, giving perhaps 30 millions for the optimum for Australia at the present high standards. (It was this low figure which so much exasperated Australian boosters some twenty years ago, though this figure is felt to be reasonable now.) As regards Canada the figure came out at 100 millions—or keeping to the standards of a rich new country, we get the first approximation of 50 millions for the sort of total that Canada may attain in a century or so. As in all these attempts at forecasts it is the *relative* values, rather then the absolute total figures, which are likely to be helpful. Thus Canada seems to me to have such large areas of empty third-class lands, that in the long run she will contain double the population of Australia, when both areas are as ' saturated ' as is Europe today.

Canada and the Geographer

In the preceding pages I have tried to show how the geographer can help Canadian development by ' grading ' the various regions, and showing how they can best be settled, and the order in which the land should be tackled. This is the second large area which the writer has investigated for this purpose ; and, as in the case of Australia, the present study supports the view that only an intensive study of the environment can show us how Nature intends a land to be developed.

I cannot do better than quote a paragraph or so from the conclusions to my study of Australia. In the early days of our science, national progress was discussed in terms of Providence, priests, potentates, and politicians ; and the environment was hardly considered. Yet whether the writer studies Europe, where man has reached some degree of equilibrium, or the newer lands of the United States (in which he spent seven years), or finally Australia and Canada, he is still fixed in his belief that Nature has largely decided the future of a country before man occupies it.

In Europe the present population-pattern bears no marked relation to the actions or desires of the aforesaid potentates and politicians. Nor do biological and cultural factors like race, religion, and language exercise any dominant influence. Yet what we may term the three servants of Nature, King Frost, King Drought and King Coal, to a very large degree have determined how man has developed the European Scene. The relation is just as clear in Australia and Canada; and although environmental control is not a popular concept among American geographers, it is as potent there also.

The writer indeed is somewhat of a determinist. He believes that the best economic programme for a country to follow has in large part been decided by Nature, and it is the geographer's duty to interpret this programme. Man is able to accelerate, slow or stop the progress of a country's development. But he should not, if he is wise, depart from the directions as indicated by the natural environment. He is like the traffic-controller in a large city, who alters the rate, but not the *direction* of progress; and perhaps the phrase 'Stop-and-Go Determinism' expresses succinctly the writer's geographical philosophy.

What place has Geography in the studies of young Canadians? Some years ago a Canadian friend of the writer's was attending the Geographical Congress at Warsaw, and there an awkward question was put to him. How is it that of all the literate nations in the world, Canada and Ecuador alone pay practically no attention to geography in their scheme of education? To the writer it seems inexplicable that a young but highly civilized country like Canada should be about the last to have a Department of Geography at any University. Toronto was the first Canadian University to do so in 1935, whereas Australia started in 1920, South Africa much earlier, and England and U.S.A. appointed important University teachers about the dawn of the century. (By 1956 geography was taught at most Universities.)

Linked with this delay in University teaching, is the unhappy condition of the schools. Since no one at the University took any special note of geography there was no place for it in the matriculation examinations. [In Canada about three times as many young folk (proportionately to population) attend the Universities as in Britain or Australia.] Hence no senior classes were arranged at 99 per cent of the schools for the study of geography, and most young folk dropped it at the mature age of 14. In recent years there has been considerable emphasis on 'Social Studies'—in which the teachers (well-trained at the Universities in history) are supposed to link up the history of a region with the geographical aspects thereof.

Ellsworth Huntington has discussed this aspect of the problem in an article 'Geography and History'[1] in the following words:

[1] *Canadian Journal of Economics*, Toronto, November 1937.

Ever since the days of Herodotus, everyone who has carefully considered the subject has recognized that a rational understanding of history requires a good knowledge of the changing physical background upon which the historical events occur. This idea has gone so far that in some parts of the United States the elementary schools attempt to combine geography and history into a single course, which aims at giving a firm and broad grounding in both subjects. The world's great thinkers consider themselves by no means so competent to produce a reasonable synthesis as do the young women who teach this elementary course.

In Canada the teachers of 'Social Studies' recognize that a considerable knowledge of elementary science is necessary before even the nomenclature of geography can be understood. Since they have done no geography—to say nothing of science—the five or six hours a week for Social Studies becomes often enough a lengthened period of instruction in history. The writer believes that history and geography should be the foundation of every man's education; but he is wholly at a loss to understand why geography should take so backward a place in Canadian education.

I have been accustomed to teach that the geography of a region represents the interplay of man and his environment *at the present time* while he himself is alive and an actor in the grand drama of civilization. History may be looked upon as a *succession of earlier stages* of the same interplay—but surely they are not as important, interesting or instructive as the *present* stage of such inter-relations. Indeed in British schools geography is more widely taught than history. It is to be hoped that our educational authorities will bring Canada into line with the rest of the world in this respect before many years elapse.

This is the age of aviation and the radio. It is a platitude to state that the world is contracting so rapidly that everyone is our neighbour. The problems and difficulties of once far-distant countries have today a very direct bearing on our own well-being. The greatest problem is, of course, to bring about a world at peace; and the geographers have a great contribution to make in this respect. One might quote the statement (made in 1945) that 250 professionally trained geographers are employed in one fashion or another in the Government offices of the United States. (An official Geographical Bureau was established in 1947 in Ottawa, and much improves the Canadian picture.)

The aim of education should be—much as put forth by Aristotle—to enable a man to make the best of his environment. Modern geography is precisely the best discipline to teach man that he is conditioned by his environment; that he himself is changing, however slightly, and is part of the mechanism of human evolution; and that he can only understand his own place in the scheme of things if he has a real knowledge of the relation of man to his environment.

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